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# Novel Devices Used in the Launching of the Battleship "New York"

(CONTRIBUTED)

The launching of the battleship "New York," at the Brooklyn Navy Yard, on Oct. 30, was unusual because of the great weight of the vessel, more than 10,000 tons, and the concentration of this greater weight over a shorter length than ordinarily is the case. Due to this weight, special precautions were observed and several new devices were introduced. The presence of the President of the United States and other high officials made it especially desirable to have the launching take place at the time set, without the delays that are frequently experienced in launchings. Some of the devices used undoubtedly had this in view.

THE RELEASING TRIGGER—For many years the "sawing off" method of releasing ships was employed in this country. This method involved extending the sliding ways, reinforced with oak sole pieces, forward of the fore poppets and securing them to the ground ways in such a manner that by sawing through the sole pieces the vessel would be released and be free to slide down the ways. This method has been successfully used many times, but it has the disadvantage of placing the whole sliding ways, as well as the fastenings, under tension so that in the large vessels of recent years considerable "creeping" down the ways has been experienced as the building supports under the ship were removed. Such "creeping" involved danger and indicated weakness of the holding arrangements, so much so that frequently it necessitated launching a ship before the time set, or even before all arrangements could be completed. In the case of the "New York" the excessive weight of the vessel and the declivity of the ways, which was $\frac{1}{4}$ in. to the foot, made it seem wise to have recourse to the hydraulic-trigger releasing device which had been used previously at the launching of the "New York's sister ship, the "Texas," at the works of the Newport News Shipbuilding & Dry Dock Co. This device consisted essentially of bell cranks, or triggers, the axes of which were secured to the

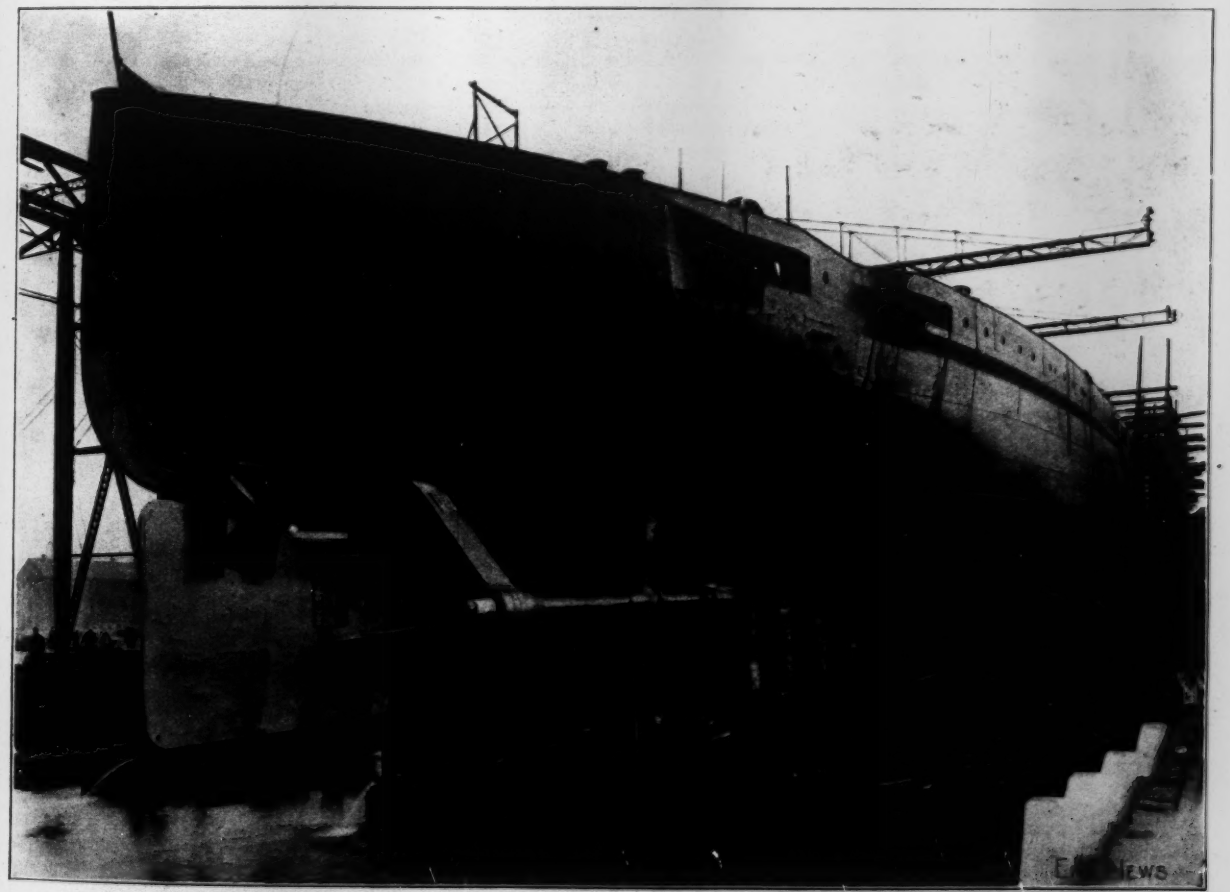
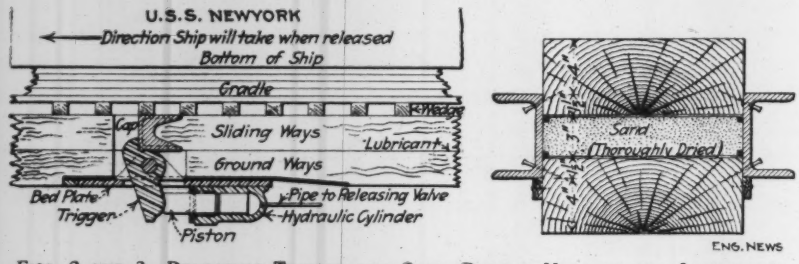


FIG. 1. STERN VIEW OF U. S. BATTLESHIP "NEW YORK," BEFORE LAUNCHING
(Showing after poppet, tumbling shores under overhang, etc.)

ground ways and their arms arranged to extend into recesses in the sliding ways. These, when up, held the sliding ways securely, but when dropped permitted them to slide. The triggers were held up by means of hydraulic pistons, and the operation of releasing the ship when all was ready consisted simply of dropping the triggers by allowing the liquid in the cylinders to escape. As the building supports were removed from the vessel before the launching, the pressure in the hydraulic cylinders increased gradually and reached 2200 lb. per sq.in. just before the launching. The device worked in an entirely satisfactory manner, and the "New York" was held practically without creeping until all preparations had been completed. The vessel was released and started to move down the ways immediately, within a few seconds of 11 o'clock, the appointed hour.




FIGS. 2 AND 3. RELEASING TRIGGER AND SAND BLOCKS USED IN THE LAUNCHING OF THE "NEW YORK"

FIG. 4. SLIDING JOINT OF THE STARBOARD FORE POPPET; LAUNCHING OF THE "NEW YORK"

THE SAND BLOCKS AND TUMBLING SHORES—One of the most difficult points in launching a large vessel is that of transferring its weight from the supports on which it has been constructed, to the launching ways. Due to the fact that the launching ways do not give support, other than locally, and to the necessity of not having the entire weight of the ship on the launching grease longer than necessary, it is desirable to leave as many supports as possible under the ship until the appointed moment. On account of the heavy pressure on these supports their removal is somewhat difficult. If they are blocking, it must be split out, or if shores they must be cut out. Having this in mind provision is made to have some means of support that can be removed readily at the last minute. On the "New York," under the keel, 50 sand blocks were used. These consisted of hardwood blocks resting on sand in a steel frame (Fig. 3). By unbolting the frame the sand escaped and pressure was released. These blocks, which were 28x14 in., were found under test to stand a pressure of 125 tons.

In addition to the sand blocks, supports for the ship were provided under the docking keels and under the after portion of the vessel in the shape of 12 tumbling shores, which were arranged with rounded corners so as to drop readily when the vessel started down the ways (see Fig. 1). These undoubtedly contributed greatly to support the ship and prevent the straining often experienced in launching heavy vessels.

THE FORE POPPET CRADLE—As a ship during launching enters the water it becomes gradually water-borne until, finally, the stern lifts, leaving the forward end of the sliding ways still bearing. This is called "pivoting." At this period of the launching, the forward ends of the ways or "fore poppets" support a weight equal to the difference between the displacement of the submerged portion of the ship and its weight. This force in the case of the "New York" exceeded 2000 tons, and neither the structure of the ship nor the sliding ways was considered strong enough to support this weight if concentrated. It was necessary, therefore, to adopt an arrangement for distributing the load. With this in view cradles of steel plates, lined with cement concrete, were fitted under the bow of the ship for a distance of about 25 ft. (see Fig. 4). These were secured to the packing above the launching ways. Also sliding surfaces were fitted in the packing on each side having the arc of a circle with a large radius. These surfaces were greased, so that sliding would take place readily when the ship pivoted and the weight thus would be distributed over the whole cradle. The packing on the two sides was held together by 2-in. steel bolts, drawn taut by turnbuckles, to prevent any spreading being caused by the wedge shape of the ship's bow at this point. The ship's structure was supported by internal shoring to prevent local deformation.

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**A Peculiar Building Regulation** is in force in most parts of Switzerland. It is required that before the erection of a new building, frames or screeds must be erected to mark out the shape of the building in profile as well as in plan. In practice this amounts to erecting at each angle of the building a pole or mast with a projecting triangular frame attached to it at the cornice level to indicate the height and projection of the cornice. The building law of the Canton Zürich requires that this framework should be erected when the plans are submitted for approval by the public authorities. The purpose of the rule apparently is to bring out, in advance of construction, the architectural relations of the building to adjoining structures and to the district in which it lies, both for aiding the municipal authorities in passing upon the plans from the architectural viewpoint and giving the neighboring owners an opportunity to judge of the effect of the proposed new building upon their interests.—["Zentralblatt der Bauverwaltung," Oct. 19, 1912.]

# The Purchase of Lime for Water Purification*

By W. F. Monfort†

Lime for water treatment is valuable in proportion to its percentage of water-soluble calcium oxide; but its value is diminished disproportionately by the presence of inert materials natural to the stone — magnesia, alumina, silica — and unburnt stone, although for other purposes these materials may be nearly harmless if not positively beneficial. Hydrated lime has been used by numerous railroad and commercial softening plants and in some smaller cities, but its relatively high cost, the difficulty of feeding it in a large way, and the abundance of dust liberated in handling it have limited its application. In most of the larger plants quicklime is used. The present discussion relates to the vagaries of specifications for the purchase of this latter material.

A contract based solely upon the percentage of lime in deliveries is unjust to the purchaser, in that he pays at contract rate for calcium oxide, however much stone and other impurities are contained. The vendor sells whatever he happens to have; the purchaser receives what he must, without recourse for expense of unloading, crushing, storing, and using a considerable proportion of inert material, which clogs slaking tanks, involves waste of power in stirring, and necessitates more frequent cleaning of tanks. That this expense is not inconsiderable is evident from the following illustration. Between cleanings 253 tons of lime averaging 90% were slaked at times last year at St. Louis when half the lime used was low in inert matter, against an average of 171 to 175 tons of 83% lime during the remainder of the year. The accumulation of pieces of core and rubbish from 105 tons of lime caused stoppage of a 10-hp. motor. The cost of cleaning a tank and starting a new one is approximately 5c. per ton greater with an 83% lime than with a 90%, not counting the waste of power in stirring. It is obvious that some system of penalizing for impurities should be enforced.

The impossibility of procuring a commercial lime containing 100% water-soluble calcium oxide influences most purchasers to write specifications upon the basis of a lower guaranteed content. In some cases this has resulted in confusion in adjustment of purchase price for better and poorer limes, with purely nominal and misleading bonus and penalty clauses.

If the vendor is to receive full payment for pure lime delivered, with neither bonus nor penalty, the increment is, of course, found by the general formula,

100 guaranteed per cent. = per cent. of contract price to be added or subtracted for each 1% variation from the guarantee. (See Table I.)

TABLE I.—INCREMENT FOR VARIOUS GUARANTEED PERCENTAGES OF LIME.

(Without bonus or penalty)

| Guarantee | Increment |
|---|---|
| 50% | 2.00% of Contract Price |
| 60 | 1.666 |
| 70 | 1.428 |
| 80 | 1.25 |
| 85 | 1.176 |
| 90 | 1.111 |
| 95 | 1.052 |
| 100 | 1.00 |

Considering a contract based upon a guarantee of 90% CaO, any bonus or penalty paid or exacted must be by an increment greater than 1.11% of the contract price; so that, for example, a nominal bonus and penalty of plus or minus 1.5% of contract price is equivalent to an actual penalty or bonus of 1.5 less 1.11, or 0.39% of the contract price for each 1% variation from 90. A nominal bonus of ½% would be an actual penalty on any basis of percentage guarantee; a nominal penalty of 1% of contract price for each 1% deviation in percentage of lime delivered below that guaranteed would be an actual bonus on any basis of guarantee other than 100% CaO.

In considering the fairness of specifications for lime it is expedient to calculate the purchase price per ton as delivered, and the cost per ton of pure lime to the user, as representing the working of the contract from the viewpoint of vendor and purchaser, respectively. By way of illustration, Table II gives an analysis of some contracts proposed or operative in connection with water-works plants.

TABLE II.—DATA ON VARIOUS LIME CONTRACTS.

| | A | B | C | E | F |
|---|---|---|---|---|---|
| Contract price.. | $4.23 | $4.23 | $4.70 | $4.23 | $3.925 |
| Guarantee..... | 90–95% | 90% | 100% | 90% | 85% |
| Nominal bonus. | 0.5% | 1.11% | ... | 1.5% | 1.5% |
| Nominal penalty | 1.0% | 1.11% | 1.0% | 1.5% | 1.5% |
| **Purchase Price** | | | | | |
| Delivery 100% | $4.33 | $4.699 | $4.70 | $4.685 | $4.808 |
| 95 | 4.23 | 4.46 | 4.46 | 4.547 | 4.513 |
| 90 | 4.23 | 4.23 | 4.23 | 4.23 | 4.219 |
| 85 | 4.018 | 3.995 | 3.995 | 3.914 | 3.925 |
| 80 | 3.81 | 3.76 | 3.76 | 3.59 | 3.62 |
| 75 | 3.59 | 3.52 | 3.52 | 3.278 | 3.336 |
| 70 | 3.28 | 3.29 | 3.29 | 2.96 | 3.042 |
| 65 | 3.17 | 3.05 | 3.05 | 2.644 | 2.747 |
| 60 | 2.96 | 2.82 | 2.82 | 2.333 | 2.453 |
| **Cost per Ton CaO** | | | | | |
| Delivery 100% | 4.33 | 4.695 | 4.70 | 4.865 | 4.808 |
| 95 | 4.452 | 4.70 | 4.70 | 4.786 | 4.751 |
| 90 | 4.70 | 4.70 | 4.70 | 4.70 | 4.683 |
| 85 | 4.727 | 4.70 | 4.70 | 4.604 | 4.618 |
| 80 | 4.759 | 4.70 | 4.70 | 4.449 | 4.526 |
| 75 | 4.794 | 4.70 | 4.70 | 4.370 | 4.449 |
| 70 | 4.83 | 4.70 | 4.70 | 4.23 | 4.345 |
| 65 | 4.88 | 4.70 | 4.70 | 4.061 | 4.226 |
| 60 | 4.93 | 4.70 | 4.70 | 3.88 | 4.088 |

PER CENT. OF CONTRACT PRICE TO GIVE PURCHASE PRICE.

| Delivery | | | | | | |
|---|---|---|---|---|---|---|
| 100% | 102.5% | 111.1% | 100% | 115% | 122.5% |
| 95 | 100 | 110 | 95 | 107.5 | 115 |
| 90 | 100 | 100 | 90 | 100 | 107.5 |
| 85 | 95 | 94.44 | 85 | 92.5 | 100 |
| 80 | 90 | 88.88 | 80 | 85 | 92.5 |
| 75 | 85 | 83.33 | 75 | 77.5 | 85 |
| 70 | 80 | 77.77 | 70 | 70 | 77.5 |
| 65 | 75 | 72.22 | 65 | 62.5 | 70 |
| 60 | 70 | 66.66 | 60 | 55 | 62.5 |

Contract A is unjust to the seller, in that the contract price obtains for any lime delivered which falls within the limits of 90 to 95%. The framers of these specifications intended to be kind in this clause; but the guarantee is actually raised to 95% for good lime, and lowered to 90% for bad, with no discrimination in what is really the highest range of commercial limes.

The increment of 0.5% above 95% is a bonus only in name, as has been shown; the vendor receives a trifle more for a 96% than for a 95% lime; but the increment is 0.61% less than the normal increment for a 90% basis (1.111%), and therefore an actual penalty is placed upon deliveries better than the guarantee. The deduction of 1% instead of 1.11 for each 1% below the guarantee leaves an actual bonus of 0.11% operative. Stated in another way, an actual penalty is put upon the delivery of good lime in that, instead of receiving 111.11% of the contract price for 100% lime, as under a contract on a percentage basis, the seller is paid under a supposed bonus clause only 102.5% of the contract price, while the purchase price on deliveries of 90% or less is always 10% of contract price above the per cent. CaO delivered.

From the standpoint of the user, the cost of pure lime is $4.70 in a 90% delivery; $4.427 in 100% delivery; $8.46 in a 10% delivery; $44.63 in a 1% delivery; whereas unburnt stone at a purchase price of 43c. per ton would afford a ton of pure lime at an infinite cost.

The vendor receives no bonus and has no incentive to furnish good lime; but, since this contract imposes no penalty for poor lime, he has every reason to send the maximum proportion of unburnt stone which will be accepted. The purchaser pays more for poor lime than for good, and suffers further losses entailed by unloading, crushing, using and removing from his tanks this obstructing material. The facts are manifest in the accompanying table and diagrams.

Contracts B and C, though differently worded, yield the same figures for cost of pure lime and for purchase price without bonus and penalty, and give normals for establishing the value of increments in other specifications.

Contract E gives a bonus and exacts a penalty of 0.39% of the contract price for each 1% deviation from the guarantee. The vendor, therefore, receives some compensation for care and labor in preparing a well burnt lime; the purchaser is safeguarded to some extent against loss in refuse material. It is probable that a larger increment would result in greater economy to the purchaser, by securing a lime of higher calcium-oxide content and reducing the power cost.

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Contract F is now operative at St. Louis, in lieu of Contract A, which was in effect last year. The contract price ($3.925 per ton for 85% lime) is the average of two lettings to the same contractor. The increment 1.5% leaves a net bonus and penalty of 0.324% of contract price, which is again too small, if the advantage of good lime to the department is considered. In the Table III comparison is made of cost of calcium oxide and of purchase price for contracts A, B and F throughout the range of percentages in deliveries for June-August, 1912.

TABLE III.—COMPARISON OF WORKINGS OF LIME CONTRACTS—1912 DELIVERIES

| | Per Cent Delivered | | | | |
|---|---|---|---|---|---|
| Cost CaO | 90 | 85 | 80 | 75 | 70 |
| Contract A | $4.70 | $4.727 | $4.759 | $4.794 | $4.83 |
| B | $4.70 | 4.70 | 4.70 | 4.70 | 4.70 |
| F | $4.683 | 4.618 | 4.526 | 4.449 | 4.345 |
| Purchase Price | | | | | |
| A | $4.23* | $4.018 | $3.81 | $3.59 | $3.38 |
| B | $4.23* | 3.99 | 3.76 | 3.52 | 3.29 |
| F | $4.22 | 3.925* | 3.62 | 3.34 | 3.04 |

*Contract Price.

The average of available lime for eight summer weeks was 85% on 1950 gross tons delivered, or 1572 tons of pure calcium oxide therein contained. Cost per ton of pure lime and purchase price fall below last year's figures by about 10c. per ton for this particular percentage.

In two cities a form of contract is used which gives a bonus and penalty of so many cents per ton for each 1% departure from the guarantee. Whether this results in payment for lime on a percentage basis; in a bonus for good and a penalty for worse lime, or in a bonus for bad lime and a penalty for better, depends upon the contract price, since the value of the increment with respect to the contract price is a variable quantity. One current contract gives a bonus of 7c. per ton for each 1% above, and deducts the same amount for variations below the guarantee (88%). Older specifications gave a bonus and penalty similarly of 14c. per ton on the same guaranteed percentage. Analyses of these specifications on the lines of the foregoing discussion give the results shown in Table IV. (The normal increment for an 88% lime is 1.13636% of contract price.)

TABLE IV.—COMPARISON OF INCREMENTS, BONUS AND PENALTY ON LIME PURCHASES

(Contract Price Assumed at Various Values; Percentage Guarantee, 88%.)

| | Nominal Bonus—14c. per ton | | 7 c. per ton. | |
|---|---|---|---|---|
| Contract price | Increment | Bonus and penalty, actual | Increment | Bonus and penalty, actual |
| $12.32 | 1.13636% | 0.0 c. | | |
| 11.00 | 1.153 | 0.01636 | | |
| 10.00 | 1.168 | 0.02164 | 1.084% | 0.05236 |
| 9.00 | 1.1866 | 0.05024 | 1.09 | 0.04636 |
| 8.00 | 1.21 | 0.07364 | 1.105 | 0.03136 |
| 7.00 | 1.24 | 0.10364 | 1.12 | 0.01636 |
| 6.20 | ... | ... | 1.13548 | 0.000878 |
| 6.00 | 1.28 | 0.14364 | 1.14 | 0.00364 |
| 5.00 | 1.336 | 0.1996 | 1.168 | 0.03164 |
| 4.00 | 1.42 | 0.2836 | 1.2 | 0.07364 |

Under the first specifications (14c. bonus and penalty) the increment is too small between $6 and $7 per ton, the probable range of prices in that district, with extinction of bonus and penalty at $12.32. Under the second specifications, extinction of bonus and penalty occurs at about $6.20 per ton, leaving above that price a penalty on better deliveries, and a bonus for poorer deliveries than are called for by the contract. The amount of bonus is too small to be an incentive to keep the quality of lime delivered up to a desirable standard. In such case dependence must be placed upon some additional clause in specifications as a basis for rejection of unsuitable material.

The common practice in commercial analysis of returning as available the total calcium oxide soluble in hydrochloric acid renders it advisable to incorporate in the specifications a statement of the method of sampling, sample reduction, and of analysis. The scheme adopted in this laboratory follows: Lump lime in bulk is received in car lots and crushed to ¼ in. or less upon receipt. By means of a small pivoted chute at the outlet of the crusher small portions at 15-min. intervals are collected during the unloading of the car, making a total sample of about 50 lb. per car. This is passed through a second crusher in order that no pieces exceed ½ in. in greatest dimension. A sample reducing machine described in ENGINEERING NEWS for Nov. 23, 1911, is used to reduce the 50-lb. sample to about 2 lb., after which the entire small sample is pulverized to about 60 mesh in a Sturtevant pulverizer.

In the laboratory a Buskett mechanical riffle reduces the 2-lb. sample to about 14 grams. Approximately 7 grams (8 c.c.) of powdered sample is accurately weighed in a weighing tube, and emptied directly into a 1-liter volumetric flask containing 70 grams cane sugar dissolved in about 800 c.c. cold carbon dioxide free distilled water. Brisk rotation of the flask before introducing the weighed sample prevents caking. Flasks are shaken on a Camp machine 20 min., and allowed to stand over night. The solution is shaken, made up to the mark, mixed thoroughly and 200 c.c. are diluted to a liter; 100 c.c. of this dilution is titrated with tenth normal hydrochloric acid, using phenolptalein. The method is a modification of one commonly used in sugar-house practice (Croghan, C. A., 1908, p. 768).

Delivery of limes containing appreciable quantities of magnesia may be guarded against by a clause in specifications, and occasional analyses made. Limes of the St. Louis district commonly contain less than 1% magnesia.

Shippers are prone to consider deterioration in transit as working a hardship to them, although the lowered percentage of calcium oxide through absorption of moisture prior to weighing on receipt is balanced by increase in weight of car contents. The protection of the bulk of the car load by the layer of finely divided (air-slaked) lime has been long known. Further, our experience of the summer of 1912 with cars of well-burned lime covered with paper during transit indicates that serious deterioration may be avoided. Two cars shipped and received on the same dates showed the advantage of "overburning" in the meaning of the lime trade. One (ordinary run of kiln, containing some core, and covered with paper, was badly air-slaked, analyzing 76.7% calcium oxide soluble in sugar solution. The other (well burned—slightly overburned in the opinion of the kiln operator) covered with paper in transit, ran 90.8% calcium oxide. Fourteen cars of overburned lime in the summer months averaged 88%. The degree of overburning was below that which would make trouble in drawing the kiln; sufficient, however, to greatly reduce the amount of core. The product slaked well. It is better described as well burned than as overburned lime.

Nevertheless, in our latest specifications a clause appears making an allowance from April to October of 2c. per ton for each 24 hr. delay in unloading after a lapse of 48 hr. from receipt on our tracks. The concession is larger than is equitable; it is, however, rarely operative.

The substance of this paper was put into the hands of all bidders on our current contracts. It is given wider circulation in the hope of directing attention of both writers of specifications and bidders to some essential facts which have been overlooked in purchasing lime for water treatment.

## SUMMARY

Specifications for purchase of lime should be based upon a single percentage guarantee.

Bonus and penalty clauses introduced to guard against loss incident to impurities should be in terms of percentage of contract price.

The increment should be sufficiently large to provide an actual bonus and penalty for variations in quality of lime delivered, and should be based upon the source and quality of lime available.

Instances are cited illustrating the injustice of specifications drawn without analysis of their workings.

Well burned lime ("overburned" of the trade) suffers slight deterioration in transit, especially if covered with paper.

Methods of sampling and of analysis should be described in specifications.

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**An International Building Exhibition** is planned for Leipzig, Germany, during the summer of 1913. Extensive treatment of the subject from the economical, architectural, engineering and sanitary standpoints is proposed and exhibits of materials, and methods, horticultural effects and safety measures in connection with all kinds of building work, will be arranged.

# Conference of Irrigation Managers at Boise, Idaho

(CONTRIBUTED)

The second of the 1912 conferences of irrigation managers was held at Boise, Idaho, beginning Oct. 24. There were present managers of various irrigation systems constructed under the terms of the Carey Act and of those built by the government under the terms of the Reclamation Act, and others interested in the management of irrigation canals.

The discussion related largely to the larger questions of management and to the necessity of having in charge of large irrigation works a man of an ability comparable to that of the manager of a railroad system.

In the distribution of water particularly there is required administrative judgment to be exercised by a man of good information, with strong backbone and steady nerves. He must decide innumerable questions as to the actual necessity for water under various conditions, and must be prepared to back up his judgment by enforcing necessary regulations.

An instance was cited illustrating the danger of putting the control of a large system into the hands of an unskilled man. A large canal was turned over by a construction company to the water users. They at once proceeded to introduce what they considered certain economies and reforms. The man chosen for the difficult position of manager was an individual who had not been long in the arid West and who had not made a notable success of farming. He had, however, a genial disposition and was known as "the best hand shaker" in the country. His many admirable personal qualities made him a favorite, and he, on the other hand, disliked to disappoint his friends or acquaintances. Whenever complaint was made of lack of water, instead of ascertaining the actual facts and rigidly cutting down the supply to the needs rather than the desires of the farmers, he would order more water turned in. He kept the canals crowded bank full with all the water which could be carried, turning out to everyone the full quantity which he desired. All this was done with the minimum of maintenance expenditures, ignoring the fact that the large volume of water in the canals, beyond their safe capacity, was eroding the sides, weakening the banks, and rapidly bringing about conditions where disaster must follow unless large and unusual betterments were provided.

At the same time the new manager was opposed to the delivery of water to additional lands, as he realized that he could not give all the water desired (though not really needed) to the lands then under the system. Thus the normal extension of the project was prevented while the lands already irrigated were being over-irrigated, the fertility reduced by constant washing, and the seepage greatly increased. In other words, an appraisal of the true value of the project would show that with the deterioration of the canal system and of the soil, the loss to the community would probably be a hundred times the relatively small saving in outlay for maintenance. Yet the manager himself was well liked and the more thoughtless of the irrigators applauded the saving of expenditure and the crowding of water into the canals, not seeing that their property was being jeopardized.

The question of power plants for irrigation was also discussed, particularly the matter of use of the power during the months when the water is not employed fully in irrigation. There has necessarily grown up a winter use of power which in one sense is wasteful, but is really necessary in order to keep the plant moving. The sale of this winter power for heating purposes, the most extravagant use of electric energy, has grown up in southern Idaho and is being extended to absorb the otherwise waste energy of the power plants and keep the organization intact.

A rough rule was given regarding the cost of pumping in southern Idaho. Contracts are being made for pumping, extending over five months, at the rate of approximately $20 per horsepower. This is equivalent in many situations to a cost of $1 per acre for water raised 25 to 30 ft. In all contracts for sale of electrical power for this purpose, provision must be made to prevent excessive load during July, and to encourage the use of water earlier or later, reducing the amount which is demanded during the few hot weeks of the summer.

The planting of grain was shown to be as a rule unprofitable under irrigation, especially under pumping. This is peculiarly the case with spring grain where the demand for water occurs during the short critical period of summer. On the other hand, winter grain might be irrigated with better effect in lace of planting in the spring.

The destroying of weeds on canal banks and rights-of-way and of aquatic plants in the canal itself was given some consideration. It was shown that experiments have been made along various lines of clean cultivation and frequent harrowing of the banks and right-of-way to keep down the weeds, or of sowing rye or perennial plants, such as blue grass or clover; the use of mowing machines has also been tried. It was shown that the planting of rye is probably least expensive; next to this comes clean cultivation or frequent mowing, and most expensive of all the planting of blue grass and clover, as these require frequent irrigation to secure a stand. Much work is yet to be done to demonstrate the advantages of various methods of keeping down the weeds. In some cases grazing by sheep or goats has been advocated, but it is difficult to force these animals to eat the weeds clean.

The growth of aquatic plants, commonly included under the name of moss, was shown to be confined almost wholly to clear water and to places where the sunlight was not obscured by trees or bridges. Shade quickly kills the moss. It grows irrespective of the velocity of the water, and in some cases the most vigorous growth is in water flowing at a rate of 20 ft. or more per second. Attempts to poison the moss in drainage ditches have not been notably successful, and even if killed the plants still remain to obstruct the flow. Mowing machines with cutters especially adapted to use under water have been tried and also various types of saw. The most successful device so far has been the dragging of a heavy chain weighing perhaps a ton, with a team of horses attached to each end, pulling the chain along on each bank.

The necessity of keeping the weeds down was shown to be especially great in cases where seed farms are located near the canal and where the clover seed, for example, is readily contaminated by seeds from similar wild plants.

Standard forms for measuring boxes to the farmers were discussed and examples cited for the use of boxes and weirs made of blocks of concrete cast in the yard, each piece being of a size to be handled by one man. It was shown that these pieces can be cast and later assembled on the ground at a cost of from $6 to $10 for each box or weir.

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**A Newspaper Description of a Bridge**—The Springfield, Mass., "Republican," publishes the following description of a bridge on a trolley line near that city:

The Jones bridge at East Lee claims the greatest attention of anything on the western section of the road, not that it was the greatest problem to be overcome, but it is unique in the engineering world, and, so far as known, there is not another structure like it in America. The acute angle at which the highway crosses the railroad and the height of the arch above the tracks are in great measure responsible for this oddity. The actual span of the bridge is but 22 ft., yet the entire structure is 370 ft. long. This is necessary because of the retaining walls which run almost parallel with the highway. There is not a crack in this entire solid concrete construction, such a result being eliminated by making the pourings tally with the beading. Hundreds of tons of iron and cement were used and when all was finished the surface was polished with machinery in days of tiresome hand work, giving the bridge the appearance of being cut from a solid block of white marble. Standing at right angles to the bridge the eye of the visitor cannot see through it. In fact, the structure does not look like a bridge, and it is hard to realize that the underside of the arch is but 22 ft. above the rails.

Concrete builders will surely welcome this sovereign preventative for cracking. "Making the pourings tally with the beading" should be the simplest matter in the world. A view of what we take to be the bridge the ambitious reporter was trying to describe appeared in Engineering News, Oct. 10, 1912, p. 679.

# U. S. Irrigation Work in the Northwest

By Robert Fletcher, Ph. D. *

**Some of the largest works on which the U. S. Reclamation Service is now engaged are located in the states of Montana, Wyoming and Dakota. Dr. Robert Fletcher, Director of the Thayer Engineering School of Dartmouth College, spent a good part of his summer vacation examining the Reclamation projects in these states. He gives in the following article a bird's-eye view of the engineering work on these notable enterprises and also gives his impressions as to what the Government engineers have accomplished in building prosperous communities as well as dams and canals.**

*Director of the Thayer School of Civil Engineering, Dartmouth College. The writer has recently inspected eleven principal projects and units, completed and in progress, in Montana, Wyoming and North Dakota, in company with General W. L. Marshall, U. S. A., retired, lately Chief of Engineers, U. S. A., now consulting engineer for the Dept. of the Interior; and H. N. Savage, Supervising Engineer of these projects in the Northern Division, involving about 2500 miles of travel by rail, automobile and wagon in these states.

The remarkable accomplishments of the engineers of the U. S. Reclamation Service since its organization, nine years ago (the enabling act was passed June 17, 1902), have been the subject of occasional articles, especially as to their more spectacular features, in technical journals and popular magazines.* But the nation at large doubtless does not yet fully understand the scope of the work or the extent and magnitude of the various projects, or have adequate knowledge of the results already gained, affecting a territory which is more than one-third of the area of the United States. It is safe to say that never before in human history has such a vast scheme of national betterment, with so many great features, been devised or made possible of execution.

According to the report of the Committee of the U. S. Senate, which inspected all the projects in 1909,† the net costs of 29 projects up to Oct. 31, 1909, amounted to almost $48,000,000, which has been furnished from proceeds of the sales of public lands. A great organization perfected with surprising celerity had to do a vast amount of preliminary work. In the attempt to meet the public demand the projects undertaken up to 1909, were so many, and scattered over so wide a territory, that the proceeds from land sales were inadequate to make satisfactory progress in the development of all.

The Senate Committee which visited, inspected and reported to Congress on all the projects naturally found and reported points for minor criticism; and to meet the exigency Congress, by Act approved June 25, 1910, authorized a bond issue of $25,000,000, but made it available only after an inspection and investigation of all the projects by a Board of Army Engineers to be appointed by the President, who were to report their findings and recommend allotments from this fund to the most needy projects. The report of this board was approved and submitted to Congress by the President in January, 1911.* The board was accompanied by Brig.-Gen. W. L. Marshall, Consulting Engineer of the Interior Department, lately Chief of Engineers, U. S. Army, and the report, which was as complete and thorough as was to be expected from such competent and impartial officers, abundantly vindicated the efficiency of the personnel of the Reclamation Service, testifying to their proved ability and the great credit due, especially in the design and construction of some of the more monumental works, like the Shoshone, Roosevelt and Pathfinder dams, etc.

The question was raised by the board, however, whether cheaper structures would not have served the purpose at the Laguna and Lower Yellowstone dams, thus lessening the cost of water rights for the farm units sold to homesteaders. At the Lower Yellowstone Dam, subsequent events have amply justified the work of the Reclamation Engineers. The

*See index to Engineering News, 1905 to 1909, for various articles and editorials. Also volumes for 1910 and 1911.

†Report No. 1281, 61st Congress, Third Session, Gov't Printing Office, 1911 (Submitted Mar. 3, 1911), a book of above 900 pages.

*Engineering News, Feb. 2, 1911, pp. 137 (ed.) and 146.

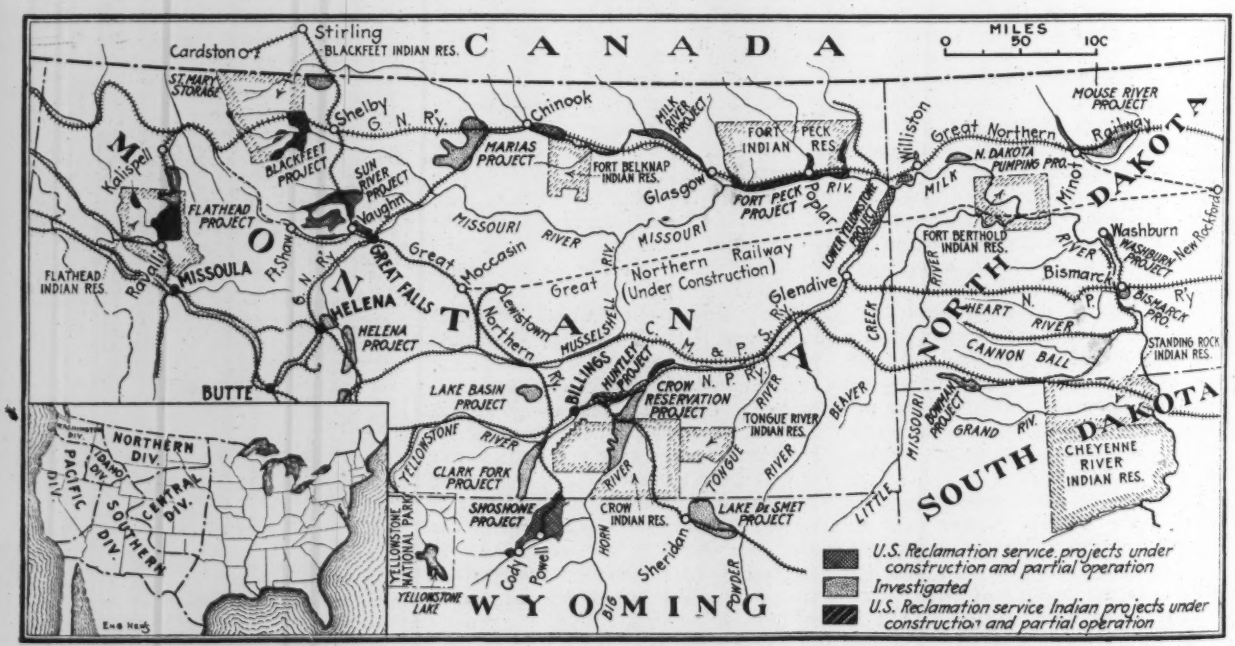


FIG. 1. MAP OF THE IRRIGATION PROJECTS UNDER THE NORTHERN DIVISION OF THE U. S. RECLAMATION SERVICE

FIG. 2. ICE AT LOWER YELLOWSTONE DAM AFTER FLOOD OF JANUARY, 1912; ICE CAKES 4 FT. THICK

dam is required to withstand a flood (overfall 700 ft. long, height 12 ft.) estimated at 175,000 sec.ft. (cu.ft. per sec.), and was subjected to extraordinary pressure and impact from a terrific ice-jam which filled the entire wide valley bottom far beyond the abutments of the dam. An impressive photograph taken soon after the subsidence of the maximum overflow, shows this bottom thickly strewn with enormous cakes and masses of ice 4 ft. thick (Fig. 2). One of the former inspecting Army engineer officers now declares that the dam might properly have been made even stronger, although the ordeal left it without serious injury, and it showed no defect in July, 1912, when an unusually heavy summer flood passed over it.

The report of F. H. Newell, Director of the Reclamation Service, for the year ending June 30, 1911, gives the financial statements for 32 projects, including three Indian Reservation projects, and treating separately the Engle Dam and Leasburg unit of the Rio Grande Project. These projects are distributed in six geographical divisions the limits of which are indicated in Fig. 1, all being west of the 97th meridian.

The Northern Division includes nine of these primary projects, but actually eleven if we consider the completed Fort Shaw unit of the Sun River Project and the St. Mary Storage feature of the Milk River Project as separate projects. The locations of these are shown on the accompanying map, Fig. 1.

Some of these projects as planned present features of astonishing extent and impressive grandeur, while the works already built and begun have many points of interest and ingenuity in the adaptation of means to ends at a low cost.

A very considerable amount of construction at various points has been authorized recently, based upon exhaustive investigations described in the Reclamation Service Engineer reports. These contain a wealth of data sometimes of more than local interest.

As these works are so far removed from the observation of civil engineers generally, and little has been published as to their development during the past year or more, it is believed that the results of a rather close personal inspection made by the writer in July, 1912, may have some points of professional interest. Attention will be directed only to the more important features and accomplishments. All figures given are from official sources.

The following tabulated statement* gives the gross costs of the projects in the Northern Division to June 30, 1912:

| | |
|---|---|
| Huntley | $1,010,339 |
| Milk River | 967,135 |
| Sun River | 872,000 |
| Lower Yellowstone | 3,081,191 |
| Missouri River Pumping | 1,029,000 |
| Shoshone | 4,128,000 |
| Indian Projects (3) | 1,812,420 |

COMPLETED PROJECTS. RESULTS

The Huntley Project and Fort Shaw unit of the Sun River Project are virtually completed and present instructive examples of the realization of the purpose of the original reclamation act. The mere statistics cited from the aforesaid annual report are, for the Huntley Project:

Reconnaissance and preliminary surveys begun in 1904; construction authorized by the Secretary, April, 1905. First irrigation, season of 1908; main unit completed same year. Entire project, 96%, completed June 30, 1911. Source of water supply, Yellowstone River; area of drainage basin, 12,000 square miles; annual run-off in acre-feet at Huntley,

FIG. 3. CONCRETE HEADWORKS, HUNTLEY PROJECT.

(Gates closed. The water passes beneath the Northern Pacific R.R. tracks and enters a tunnel driven through the rocky promontory, along which the railway and river run).

*From the report of the Director, F. H. Newell (nearest even dollars).

1904 to 1910, maximum, 7,040,000; minimum, 4,590,000; mean, 5,800,000. Reservoirs, dikes and dams, none. Length of canals, 9.5 miles, with capacities greater than 300 second ft.; 19 m. with capacities from 300 to 50 s.f.; 250 m., capacities less than 50 s.f. Tunnels, three; aggregate length, 2654 ft. Water power, estimated total of 600 hp.; developed, 286, net. Irrigable area: Entire project, 32,405 acres. Present status: entered subject to reclamation act, 20,646 acres; open to entry, 4967; private ownership, 3192; withdrawn from entry, 3600. Material excavated: Earth, 1,443,000 cu.yd; indurated material, 15,200 cu.yd.; rock, 10,000 cu.yd. Concrete placed, 11,300 cu.yd. Average elevation of the area, 3000 ft. above sea level; average annual rainfall, 12 in.; range of temperature, 35° to 100°. Length of irrigating season, May 1 to Sept. 30, 153 days; character of soil ranges from heavy clay to light sandy loam. Principal products: Alfalfa, oats, barley, potatoes, sugar beets. Principal markets: Billings, 12 miles; St. Paul and Minneapolis, 879 miles; Denver, 830; Kansas City, 1038 miles.

These mere statements and figures, however, cannot be understood and appreciated until the country itself has been seen. The determining factor, of course, in such a development is topography. The Yellowstone Valley at this point, and for a long reach above and below, is an apparently flat bottom-land from one to three miles and more in width, bounded by steep escarpments 150 to 250 ft. in height, like the palisades of the Hudson, only much brighter and more varied in color.

Beyond these edges the "benches" or table lands (relatively to the river bottom) stretch away indefinitely in rolling plains or irregular hills. In this land of illusive landscape and uncertain perspective, where "one can look farther and see less" than almost anywhere east of the Mississippi, the man with a level takes the lead.

The Yellowstone River from Billings to Glendive, a distance of 226 miles, has a fall of 950 ft. In the upper reaches of the valley on one of the tributary streams (on which lies the Shoshone Project), the entire country, benches and bottom lands, has a downstream slope of 30 ft. per mile.

At Ballantine, 14 miles below the Huntley Project intake gates, where the main canal is 3½ miles back from the river, it has a drop of 33 ft. through two reinforced-concrete pipes, each 62 in. in diameter. Here the fall is utilized to actuate turbine-driven centrifugal pumps which raise 56 sec.-ft. of water 45 ft. into a high-line canal which continues six miles further and is designed for nine miles of lateral extensions to control the Fly Creek region.

The main canal continues past Pompey's Pillar to the vicinity of Bull Mountain, giving the project a total length of 29 miles and a width varying from one to three miles to the Yellowstone River which bounds it on the north. The main canal has another drop of 41 ft. further on, also made through concrete pipes.

The limit of area of the farm units under the Act is 160 acres, but farm units of 80 and 40 and even 20 acres are available, depending upon the ability and resources of the homesteader. The average duty of the water on all the projects in the Northern Division, season 1911, was 1½ acre-ft., varying from 1.18 to 1.94 acre-ft. at the farm.

The administration recommends relatively small farm units, because even industrious and worthy men, through lack of capital and inexperience are usually unable to develop the larger units and return the cost of the works in ten annual installments. The department now permits entrymen, who need or desire to do so, to successively subdivide their entries, retaining one-half and accumulating on the retained half area all the building charges previously made on the entire area of the original entry. The settlers average to break and cultivate and irrigate about 15 acres the first year and add about 10 acres each successive year, usually sowing grain, preliminary to seeding to alfalfa. Many of the settlers, however, have secured surprising yields of sugar beets the first year on raw lands.

The building charge assessed against the Huntley Project land for the construction of works is $30 per acre. The settler also pays an additional $4 per acre, the appraised value of the irrigable lands which were a part of the Crow Indian Reservation, the value of which is returned to the tribal funds. The cost of operating and maintaining the canals has been about $1 per acre annually for three seasons.

Thus the first payment for 40 acres would be made up as follows: $1 per acre on account of the Indian fund (20c. per acre, for four consecutive years thereafter); $3 per acre (first one-tenth payment) for the water right; $1 to cover estimated annual operation and maintenance, total $5 per acre or $200 for all, plus the filing fee of $6.50, making a total of $206.

The wild growth on the land is sage brush and grass, and the cost of breaking and preparing the land for irrigation is about $7 per acre.

When this project was opened to entry in 1907, 582 farms were available, and since that year the possibilities of this new country have attracted 550 permanent settlers, and with their families they are demonstrating the value of hard work when coupled with fertile soil and an assured irrigation supply. Twelve thousand acres were under full cultivation during the season of 1911, and 16,000 in 1912.

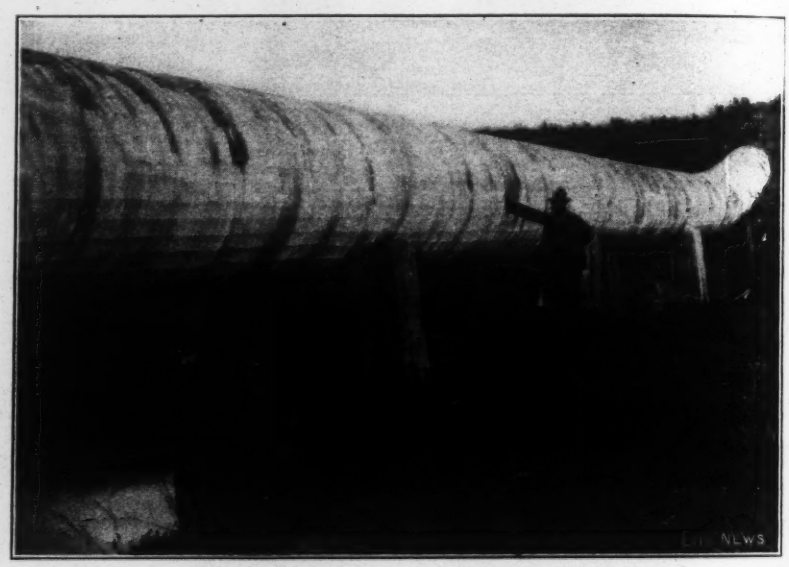

FIG. 4. SIMMS CREEK REINFORCED-CONCRETE PRESSURE PIPE, FORT SHAW UNIT, SUN RIVER PROJECT, U. S. RECLAMATION SERVICE

A great many of these settlers came from Mississippi Valley states and were equipped with farming experience which they have been quick to adapt to irrigation methods. Among the settlers there are, however, many who had never farmed before, and in this latter class are some of the most successful farmers on the project. If the settler profits by the experience of his neighbors and studies the results obtained on the government experiment farm not far from Huntley, there is no reason why an inexperienced man should not be successful.

The farms are small, averaging about 50 acres of irrigable land, the neighbors in consequence are near-by on all sides, and this close settlement makes coöperation easy and goes far to promote helpful and pleasant social relations.

The capital necessary to make a start on one of these farms depends so much upon the capabilities of the individual that no exact amount can be fixed, but at least a thousand dollars will be required. Alfalfa is cut three times during the season. It yields from five to seven tons to the acre, and some of the best farmers have harvested eight tons to the acre.

FIG. 5. SPILLWAY AND INLET OF SPILLWAY TUNNEL AT THE SHOSHONE RESERVOIR

(The spillway crest is 350 ft. long and it is at an elevation of 233 ft. above the original bed of the stream. The Shoshone dam is distant 1000 ft. to the right, around the point. Above the spillway is seen the road tunnel cut through a remarkable horizontal dike of trap rock, 10 ft. thick, squeezed between the hard porphyritic granite of which the mountain is chiefly composed. Photograph taken Sept. 19, 1912).

The average selling price ranges from $5 to $8 per ton, and in 1910 it reached $12.

Sugar beets are an important and profitable crop on the Huntley Project; 3600 acres of sugar beets were harvested in 1911, the yield averaging about 12 tons per acre, for which the farmers received $62.44 per acre; 5000 acres of sugar beets will be harvested on the project this season, 1912. By using proper agricultural methods the yield can be increased to 15 tons or more, and some of the Huntley farmers have reported profits of $50 per acre after all charges had been deducted. The beet-sugar factory at Billings pays about $6 per ton for the beets, depending upon the per cent. of saccharine, and has established seven beet dumps on the project, thus making short hauls for the farmers.

The total agricultural products grown in 1911 on Huntley Project irrigated lands, together with the live stock produced amounted to an average value of over $32 per acre for every acre of irrigated land, and there also was a material increase in the value of the farm lands. With diversified crops and intensive methods of farming it is possible to realize net returns ranging from $500 to $2000 a year on a 40-acre tract. From the Billings *Gazette* of Aug. 13, 1912, we quote as follows:

The Huntley Project received a real boost in the record made by M. W. Kesler, who lives on one of the 40-acre tracts on the project, one-quarter mile north of the Wheatley school, just east of the town of Huntley. He has divided his 40 acres into small tracts on which he has planted a variety of crops, all of which did unusually well. Mr. Kesler did all the work on his ranch himself with the help of his 11 children, all but two of which are of school age and attended the Wheatley school, so that his labor did not cost him anything, and last fall, after he had disposed of all his crops, Mr. Kesler put $2385 in the Huntley bank, being the net earnings from his 40-acre tract. A total of 17 acres were planted to sugar beets, for which the Billings Sugar Co. paid Mr. Kesler $1550. Mr. Kesler raised a large number of turkeys from which he received $75, and six hogs and two cows, together with a large number of chickens. The receipts from the small garden near the house, and from the two cows, six hogs and chickens, paid all of the farmer's expense for the year.

There are eight townsites on the project—Huntley and Osborn being common to both Northern Pacific and Chicago, Burlington & Quincy Railways; Worden, Newton, Pompey's Pillar and Bull Mountain being on the Northern Pacific Ry., and Ballantine and Anita being on the Chicago, Burlington & Quincy Ry. There are five daily trains each way, and the average distance of the average farm from a railway station is 1⅝ miles. The domestic water supply is obtained from wells at depths of from 15 to 50 ft. Cost of completing a well, from $1 to $2 per ft.

Already there are 14 school houses within the project district (bonds have recently been voted for the construction of four central high schools); eight church organizations have already been established. The Supervising Engineer, having a vision which looks beyond the merely material aspects of these communities, invited attention to this field from the heads of the leading church-extension associations of the United States and of the National Y. M. C. A. organization for promoting industrial education and clubs. A number of churches have been erected, one recently costing $4000.

Good public roads extend to all parts of the project lands, and many of the farms are connected by a telephone system which will soon include the homesteads of half of the project. A rural delivery system is in operation throughout the project, and several banks have been established. The county establishes a public school where there is an assured attendance of 10 pupils. School funds are derived from taxes on railroad property, town lots and improvements, private lands and personal property.

Here is a typical example (a single one among others on the various projects

of the Reclamation Service) of the scientific building up of a thriving agricultural community in four years (date of first cultivation season 1908). It is described in detail as being one of the best of modern instances where civil engineers have served as pioneers for agriculture.

When some of these project settlers stop and think about it, they can contrast their splendid opportunities for home-planting and farm-building with the refractory and strenuous conditions encountered by their forefathers, who for several successive generations were compelled to struggle against adversities in the shape of primeval forests, hostile natives and no markets.

The Fort Shaw unit of the Sun River, having been practically completed in December, 1909, may be properly considered by itself. It consists of a solid body of irrigable land located on the south side of Sun River, containing 17,000 acres and is traversed by the Sun River branch of the Great Northern Ry. This tract is 25 miles west of Great Falls and 200 miles in air line northwest of the one just described; the opportunities, characteristics and results are similar to those of the Huntley Project.

### Montana

One who scans even the best contour maps of Montana, can gain but little idea of the local geographical and topographical conditions. He will not be able to realize the vastness of the state with an aggregate of square miles exceeding that of all New England, New York State and nearly all of Pennsylvania. The Yellowstone River, the great geographical feature of the southern part of the state, is more than 500 miles long by its course from Gardiner, the gateway of the Yellowstone Park, to the junction with the Missouri just east of Mondak (Montana-Dakota line). In this distance it falls about 3400 ft. (from about 5240 to 1840 ft. above sea level).

### Shoshone Project, Wyoming

One of the principal Southern tributaries of the Yellowstone is the Shoshone, known on the older atlases as Stinking Water River, expressive of the strong smell of hydrogen sulphide given off from the soil of the great cut-banks between which it flows, and from other banks containing decomposing sulphides, especially in the region above Cody, where the celebrated DeMaris Hot Springs are located.

About 50 miles east of the eastern boundary of Yellowstone Park the waters of several streams, fed all summer by melting snow among the great mountain masses along that border, flow toward a deep chasm between Cedar and Rattlesnake Mts., where the North and South Forks of the Shoshone River converge.

Here was built the Shoshone Dam, one of the great features of this project, and the highest dam of the world. Its visible height is 250 ft., but the foundations extend 78 ft. below the water level to make a sure junction with homogeneous granite.

The width across the chasm at the original stream bed is only 75 ft., the dam at base has a thickness of 108 ft., the top being only 200 ft. long from cliff to cliff. It is arched upstream, with a radius of 150 ft. The parapet, 328.4 ft. above the deepest excavation, is 5370 ft. above sea level and the mountains on either side rise to 7300 and 8000 ft.

After traversing about five miles up this mighty gorge, over a dizzy road along the talus and shelves cut from the rocky sides and through tunnels which pierce projecting points of solid granite, this lofty dam, blocking the gorge like a huge wedge to hold the mountains apart, presents an aspect of almost terrifying grandeur.

This construction road had to be built to get access by teams to the dam site. At one end of the dam it pierces the mountain at a level 35 ft. above the parapet. The spillway discharges through another tunnel 20x20 ft., cut through the mountain underneath the road tunnel.

The storage reservoir thus formed backs up both branches of the Shoshone River a distance of 6 and 7 miles, respectively. It covers about 8 sq.mi. and has a capacity of 464,000 acre-ft., equivalent to an average depth of 90 ft., over the area stated. The spillway is located 1000 ft. away from the dam; it was formed by shooting out a horizontal deep trench along the face of an almost vertical rock cliff, the escape being through the 20-ft. square tunnel, 500 ft. long, with a 10% grade, discharging into the cañon below the dam.

The spillway has a broad lip of concrete 350 ft. long, built upon the rock at an altitude of 233 ft. above the original stream bed.

There are two outlet tunnels from the reservoir. The lower, located at the elevation of the original stream bed, is 10 ft. square and 500 ft. long, the other, 9 ft. diameter, is midway up from the bottom. There are also two 42-in. iron pipes piercing the base of the dam, through which water is discharged to fill the requirements of water rights along the stream below. The dam was completed in January, 1910, and it was filled to 4½ ft. below the spillway crest in July, 1912.

As to the character of the workmanship on this dam and spillway, the inspecting engineer, Gen. Marshall, who was a pioneer in the adoption of reinforced concrete, which he used in more than 50 locks and other structures on the Hennepin Canal, has testified that it is one of the finest pieces of concrete construction he has ever seen. The surface is free from crazy marks, even after three winters' exposure.

About 15 miles below the dam, is built the Corbett Diversion Dam of the Ambursen type, with an overfall 400 ft. long, 16 ft. drop, and a bay for collecting and sluicing away the sediment. This dam is extended from one end by an earth embankment 400 ft. long, across the remainder of the river bottom. The masonry is reinforced concrete and in quality and finish one of the best specimens of that kind of construction.

From one end of this dam the Corbett diversion tunnel, 3½ miles long, is cut through the high bench 100 to 150 ft. high on the north side. At the lower end of the tunnel, which has a cross-section of 102 sq.ft., is a settling basin and a sluicing tunnel in the rock the gates for which are controlled from above through a shaft sunk from the surface of the bench.

Here begins the lower left-side canal system on the north side of the Shoshone River extending nine miles to the Ralston Reservoir and thence four miles to a point where the Frannie Canal, 550 sec.-ft., diverges parallel to the 4800-ft. contour, while the main canal extends on a straight tangent northeastward through Powell, 10 miles to Garland.

In the vicinity of Ralston, Powell (headquarters of the project) and Garland, canals and regulating works have been completed on this Garland division to cover upward of 40,000 acres of land. The main canal has a maximum capacity of 1000 sec.-ft. The topography may be appreciated by the statement that there are 31 drops in the main line tangent of the Garland canal. These vary from 6 to 10 ft., and practically all serve as turnouts for lateral canals diverging from both sides, and several have bridges in conjunction. All these permanent works are of reinforced concrete.

The slope of the country is about 30 ft. to the mile in the direction of this canal. There are already completed on the project about 25 miles of canals of 300 sec.-ft. or more capacity; 26 miles 50 to 300 sec.-ft., and 190 miles capacity less than 50 sec.-ft.

Two kinds of drops are used, here and elsewhere, by the engineers of the service. One is a straight overfall into a pool 5 or 6 ft. deep contained in a basin of reinforced concrete. The other form of drop is an inclined channel with a broad bottom and flaring sides spreading out to about double width at the foot and with sufficient apron to prevent scour of the channel at that point.

The Shoshone Project is unique in the fact that behind it is a large and expensive storage system. The original contractors for the Shoshone Dam undertook the work at a cost far below the possibility of successful execution, and the sureties were obliged to complete the work. The total cost of the dam and appurtenances, including land damage, to June 30, 1911, was $1,200,000. In the

Shoshone Project the Corbett diverting works cost $1,300,000; including the dam, $97,000; the tunnel, $1,168,000, and settling basin, spillway, gatehouse and sluicing tunnel, $25,000 more. These are very interesting features of the project and have worked with entire satisfaction since the first irrigation during the season of 1908. The cost was greatly enhanced by the remoteness of locality, difficulty of access, and of procuring and retaining laborers, and consequent high wages.

The Chicago, Burlington & Quincy R.R. extends from Billings up the Clark Fork and over into the Shoshone valley to Frannie and thence through Garland, Powell and Ralston to Cody, seven miles below the great dam.

The average elevation of the Shoshone Project irrigable area is 4500 ft. above sea level, with an average annual rainfall of about 7 in. and range of temperature from −31° to 101°.

The area of the drainage basin is 1380 sq.mi. The annual runoff in acre-feet of the Shoshone River near Cody in seven years was: Maximum, 1,420,000; minimum, 905,000; mean, 1,156,000. It is proposed eventually to drive a tunnel through Rattlesnake Mountain around the north end of the dam to divert water into a high-line canal running along the base of Heart Mountain and northward. About two miles east of the mouth of the Corbett tunnel it is further proposed to divert water from the river opposite Corbett tunnel to irrigate the Wildwood Division of 25,000 acres. The length of this canal will be about 25 miles. Eventually it is proposed to divert water by a tunnel around the south end of Shoshone Dam and conduct it 30 miles into the Oregon basin southeast of the reservoir, whence 100,000 acres may be irrigated. When all this is accomplished the total area under the project irrigated from the Shoshone Reservoir will be 264,000 acres, or 412 sq.mi.

### Lower Yellowstone Project

The distinguishing feature of this project is the Lower Yellowstone diversion dam, located 18 miles below Glendive, Mont. This diverts 800 sec.-ft. of water into a main-line canal 64 miles long, extending to the junction of the Yellowstone and Missouri Rivers. The dam is a timber-crib, rock-filled weir, containing 9017 cu.yd. of rock-fill covered with timber, shaped to an ogee face; maximum height, 12 ft.; length of overfall, 700 ft.

It was an exceedingly difficult piece of construction, requiring heavy coffer-dams for unwatering the river bottom in sections. Lines of heavy square timber sheet-piling are driven under the upstream and downstream toes and under the end of the broad apron downstream; 12x12-in. or 10x10-in. square timbers were used with strips of 3- or 4-in. plank spiked two on one side so as to form the groove, and one along the middle of the opposite side so as to form the tenon strip. These are properly shod and make either a cutoff or coffer-dam wall both tight and very strong.

The headworks on the west bank are very simple, a recess with heavy walls of concrete and suitable gates controlling the flow into the canal—but without settling basin or sluicing gates for deposits. The fall of the water discharged from the main canal into a lateral near Savage, 19 miles below the headworks, will be utilized in driving two turbines for operating centrifugal pumps to raise water for irrigating approximately 3000 acres of bench land. The possible development is 64,000 acres, of which 45,000 acres are now developed and bids have been received for all extensions. Average elevation, 1900 ft.; average annual rainfall, 16 in.; range of temperature, −36° to 108°.

Although the dam was only completed in February, 1910, the population on the farms was then estimated at more than 1800, with six towns along the line, including Sidney, the present terminus of the branch line of the Northern Pacific R.R., which is now being extended to serve the entire project. The building charge has been fixed at $45 per acre.

### Missouri River Pumping Project, North Dakota

This project is situated about 30 miles east of Mondak. The area irrigated and irrigable extends about eight miles along the north bank of the Missouri River and in a narrow strip reaching northward along Little Muddy Creek 16 miles. Its distinguishing feature is an electrical energy-generating and pumping station three miles north of the river with a convenient coal mine close to the works which supplies a very good grade of lignite coal.

On a barge on the Missouri River, at Williston, a series of motor-driven centrifugal pumps raise the water to a settling basin and to a main canal extending along the creek. From the end of this main canal, steam-driven pumps located in the aforesaid central power house lift the water to what is known as the "E" canal. This power house also generates the current which is delivered by a transmission line to a second pumping station which lifts the water to a high-line canal

Fig. 6. Electric Power Pumping Barge on the Missouri River, at Williston, North Dakota

by electric motors and to another pumping station which lifts to an intermediate level. The three lifts are approximately 28 ft. each, giving distribution to laterals for the corresponding three levels. The power estimated for Williston unit and the connecting Buford-Trenton Unit is 1500 hp. for each. Average elevation of irrigable area, 1900 ft.; average annual rainfall, 15 in.; range of temperature, —49° to 107°. The building charge per acre under the old public notice was $38. The charge for operation and maintenance for 1911 was $1.50 per acre-ft. of water delivered to the land.

The Buford-Trenton Project is located 25 miles west of Williston, along the Missouri River, and is operated under very much the same conditions as the one just described. It is irrigated by means of a pumping plant on a barge in the Missouri River similar to the other one, the power being furnished by a transmission line 29 miles long from the Williston power house. The entire irrigable area in both projects exceeds 26,000 acres, of which about 23,000 were in private ownership.

### Sun River Project

This is one of the largest as well as one of the most difficult works yet undertaken by the Reclamation Service. A total of 322,000 acres situated in four counties and extending 75 miles from the base of the Rockies to Great Falls and beyond on the Missouri River may ultimately be irrigated, provided sufficient water is available. Concerning this project, Gen. W. L. Marshall, after inspection and thorough study of the project, remarked:

> If I had my life to live over again, and was looking for a piece of work with which to top off my professional career, to leave an enduring monument by which I would be remembered, I would pick the job of designing and constructing the Sun River Reclamation Project.

Semi-arid and heretofore utilized only for grazing, this vast tract, when irrigated, will be worth upward of $100 per acre as it is intensively cultivated. Eventually the lands lying near Great Falls will probably be divided into tracts of two or three acres each and, with the building of interurban railroads, will become the homes of the Boston & Montana smelter workmen and other city dwellers. Lands farther distant will be divided into 40- and 80-acre units, but the ultimate average will probably not exceed 40 acres to each farmstead.

When the Huntley Project was cut into farms of this size, bitter protests were raised. These have changed since into praise for the Supervising Engineer, whose astute foresight was responsible for the 40-acre units, and the unparalleled success of the already more than 500 settlers. Last year's tax-assessment returns of Yellowstone County showed the Huntley Project as the most prosperous part of the country.

Because of its bigness and the many and difficult engineering features the Sun River Project involves, only the government could undertake it. The total estimated cost is upward of $13,000,000. The Great Northern's Great Falls-Shelby line traverses the eastern side of the project. Three transcontinental railway companies are now making surveys to or across the project, and it is certain that within the next few years transportation facilities will be unexcelled.

The average elevation of the irrigable area is 3700 ft., the growing season is long, and all crops adapted to this latitude can be grown with success. The lands lie on both the Sun River and Teton River slopes. The water supply will be taken not only from Sun River and its tributaries and those of the Teton River, but from tributaries of the Flathead River on the west slope of the main range, the diversion being effected through a low pass across the main range of the Rocky Mountains. The area of the Sun River drainage basin is 1500 sq.mi., from which the average annual runoff is 800,000 acre-ft., enough water to cover 400,000 acres 2 ft. in depth. This runoff will be impounded in five storage reservoirs.

The greatest of these reservoirs is the Sun River. Ten miles back in the mountains from the mouth of Sun River Cañon, just below the confluence of the south fork of the north fork with the north fork of the north fork of Sun River will be built one of the big dams of the world. It will be over 300 ft. high, 1000 ft. long on the crest, and will contain upward of 300,000 cu.yd. of concrete. It will flood 3572 acres and impound 269,000 acre-ft. of water.

A road 10 miles long has been blasted and built up Sun River Cañon to the site. Two diamond-drill machines have been boring away since February to determine the character and quality of the foundation. Because of the thousands of tons of material that must be transported, construction of this dam will not be started until railroad facilities are available. The Great Northern Ry. Co. has recently surveyed a line from the terminus of the Augusta branch to connect near Columbia Falls with the present main line. This passes the big reservoir.

The general outline of the ultimate possibilities of the project is as follows: Diversion of Bowl and Basin Creeks, tributaries of the Flathead River across the continental divide into the Sun River drainage basin; construction of the Sun River, Pishkun, Muddy Creek, and Benton Lake reservoirs; the completion of the Willow Creek Reservoir; the construction of the Sun River Diversion works at the mouth of the cañon, the Pishkun Reservoir Supply Canal, and of the Willow Creek Reservoir supply canal; the construction of the Sun River slope canal and its distributing system for the irrigation of 90,000 acres in the Sun River Valley, and lying on the north side of Sun River; the construction of the Teton River slope canal and its distribution system for the irrigation of about 179,000 acres lying on the south side of the Teton River; the construction of the Sunnyside Canals covering about 16,000 acres lying on both sides of the lower Sun River, and of the Benton Lake canals, covering about 21,000 acres lying south and east of Benton Lake.

Construction was begun on the first unit in 1907. The Fort Shaw Unit is finished. Its main canal is about 17 miles in length and has a capacity of 200 sec.-ft. of water. About 100 miles of laterals have been built on this unit.

The Willow Creek Dam has been finished for a reservoir capacity of 16,700 acre-ft. It will eventually flood 2696 acres of land and impound 86,000 acre-ft. of water. It is an earth-fill dam which, when finished, will be 110 ft. high, 4300 ft. long on the crest and will contain 734,000 cu.yd. of material.

Work will be under way this season on the Sun River Diversion Dam, and the Pishkun Reservoir Supply Canal. In the mouth of the North Fork of the Sun River Cañon, just before the stream debouches from the battlemented limestone cliffs, beneath mountains 2500 ft. high, the diversion dam will be built. It will be 142 ft. high and 180 ft. long on the crest. It will be made of concrete.

Through a tunnel driven through the cliffs a distance of 1000 ft., the water will be diverted into a Y-shaped canal on the south bank of the stream. One fork, with a capacity of 200 sec.-ft., will discharge into the Willow Creek Reservoir, 11 miles distant. The other fork will turn northeasterly, and spanning the North Fork of Sun River in three steel-pipe lines on a steel bridge, will deliver 2500 sec.-ft. of water to the Pishkun Storage Reservoir, 14 miles away. For the volume of water carried, this canal, when built to the ultimate capacity projected, will be one of the largest in the world. Through it will pass more water than is flowing in the Missouri River at Great Falls at low-water season. To handle this huge volume of water safely is a difficult problem.

The length of the whole Sun River system, from the diversion tunnel through the continental divide, down the gorges where snowbanks lie all summer, to Great Falls is more than 125 miles by road and trail, and the width of country which will receive the waters is 25 miles along the meridian through Fort Shaw; the waters will be spread over 500 sq.mi.

The great concrete storage dam as designed is peculiar. The lower part (nearly half the height) will be built in a narrow, jagged chasm 15 ft. wide at

the bottom and 150 ft. deep. In this the dam will be arched to 150 ft. radius and will be 100 ft. thick. The upper 178 ft. in height extending over the bench rock on either side—length 1000 ft.—will have a gravity section built either way in continuation of the curvature of the lower part. The spillway will be made beyond the north end by cutting down the spur of the mountain so as to leave a face 150 ft. high and building a straight tangent concrete lip in shape of a low dam 3½ ft. high and 250 ft. long upon the hewn rock surface.

The diversion dam (concrete) 10 miles below, will be built similarly in a narrow chasm, 412 ft. deep, as an arch with 100 ft. radius; the upper part a gravity section 180 ft. long curved in the middle, straight at the ends, the entire crest to serve for an overfall to discharge an estimated maximum flood of 25,000 sec.-ft. Greatest height of dam, 146 ft.

Sixteen million feet, b.m., of standing merchantable timber has been acquired by transfer from the U. S. Forest Service, located in the Sun River Drainage Basin above the Sun River Diversion Dam site. A contract has already been awarded for manufacturing one million feet of this timber into lumber for use in various construction on the project.

The Supervising Engineer's plans now contemplate the development of electric energy and its transmission throughout the project to furnish power for constructing all of the works, and incidentally the electric energy so utilized at first will automatically become available for the use of the towns and for lighting, heating and miscellaneous requirements of the settlers. The development of electric energy in advance and its utilization for construction and subsequent miscellaneous uses marks a distinct pioneer engineering advance in policy and methods and reflects great credit on the Reclamation Service for its conception and initiation.

### Milk River Project

On the eastern side of the Glacier National Park, a few miles below the Canadian boundary, are the upper and lower St. Mary lakes, fed principally by melting snows and great permanent glaciers among the high mountain valleys and gorges. The St. Mary River flows northward from the lower lake into Hudson Bay and 500 sec.-ft. of its waters have been already appropriated for irrigation by a Canadian company authorized by grant. A few miles eastward from this river in the northwest corner of the Blackfeet Indian Reservation, are the sources of the Milk River. Two principal forks from this flow northeastward into Canada, where the Milk River runs a tortuous course eastward for a distance of more than 100 miles measured on the boundary (but much more than this by the river course), thence crossing back into the United States and flowing southeastward and eastward joins the Missouri about 360 miles, as the crow flies, from the head of the lakes.

After a prolonged investigation and a period of negotiations, covering 10 years, a treaty was made with the British government allowing the United States to divert from the St. Mary River below the lakes 850 sec.-ft. of water by a canal leading into the Milk River. The water so diverted is to be allowed to flow through the entire course of the Milk River in Canada so as to be available for the irrigation of a district extending more than 150 miles along its course in northern Montana.

This situation has led naturally to the designation of the storage and diversion of water from the St. Mary Drainage Basin to the Milk River as the "St. Mary Storage Feature of the Milk River Project," which includes a very large storage dam by which the two St. Mary Lakes would be merged into one reservoir with an aggregate capacity of 218,000 acre-ft., and length of 17 miles. The location of the dam, determined after exhaustive investigations, including digging many test pits and putting down a great number of drill holes, some of them to a depth of 175 ft., and making experiments on percolation through the soil, is such as to require a maximum height of 46 ft. and length of half a mile.

Into this reservoir it is proposed to divert Swift Current Creek, which at present joins the St. Mary River some distance below the projected dam.

The St. Mary Canal, beginning at a diversion dam and headworks about ½ mile below the storage dam, will be built along the west side of the valley for a reach of nine miles, approximately parallel to the 4500-ft. contour, to a crossing beyond station 485, the east side being avoided because of treacherous ground. The crossing of Kennedy Creek, another torrential stream from Glacier Park, will be by a double reinforced-concrete conduit 10 ft. in diameter. The "St. Mary River crossing" will be a notable structure, 3300 ft. long, from a concrete entrance channel at grade 4435, descending by two riveted steel pipes, 155 ft. to grade 4280, on which it continues across the river and bottom by two steel bridges, each of 100 ft. span, and a series of concrete piers, then rising to grade 4415, into a concrete exit channel.

Power will be developed at the foot of this drop for which turbines and generators have been ordered. Electrical energy will be developed, transmitted and used to actuate mechanical shovels and supply power for all construction requirements of the St. Mary Storage Feature involving the excavation of nearly three million cubic yards, and the construction of the St. Mary Lakes Reservoir Dam, which may require about 500,000 yd. of embankment.

A 70-ton steam shovel and a 60-ton drag-line scraper began excavating St. Mary Canal early in August, 1912. Cost of St. Mary Storage estimated at $2,000,000.

The Milk River Project plans aim to utilize the diversion from St. Mary River, also the discharge of the Milk River and all tributary flow in the United States to irrigate a district extending 154 miles along the Milk River in northern Montana. There will be five main canals each 30 to 40 miles long, the largest with a capacity of 1250 sec.-ft. Possible development is 253,000 acres in combined Chinook, Malta and Glasgow Divisions. These canals will be operated in connection with a number of diversion dams and storage and regulating reservoirs, existing and to be built. The distance through which the waters flowing through this project will be under control, from the head of St. Mary Lakes following the sinuosities of the Milk River to its junction with the Missouri, is over 500 miles.

Fig. 7. Blackfoot Indians and Their Teams Building a Highway Across the Blackfoot Indian Reservation, Sept. 4, 1912

### Projects in Indian Reservations

There are three irrigation projects well begun in the Indian Reservations of Montana. The Office of Indian Affairs is in charge of appropriations and the Reclamation Service of engineering, designs and construction. The Fort Peck Project, planned for 152,000 acres, extending 100 miles along the north bank of the Missouri River and tributaries, immediately east of the Milk River Project, is yet

only in the very early stage of development. Indian allotments have been made for about 90,000 acres of irrigable land; works are now completed covering 7500 acres of allotted land.

To gain access to the work on the St. Mary Diversion Canal, which is near the Canadian line, the Reclamation Service has been authorized to build 80 miles of road through the Blackfoot Indian Reservation. The Supervising Engineer is employing Indians on this work as far as possible. He states that 160 four-horse teams owned by Indians and driven by Indians were employed on reclamation work on Blackfoot Reservation at one time this season. The pay for each man is $2.50 per day as a teamster and $2 for his team; and there are many others at work with their teams as laborers on the various projects, becoming self-respecting wage earners. At Two Medicine Dam the writer saw some not only doing the scraper act, but also bending and otherwise handling reinforcing steel, a conjunction of the "age of stone" (arrow-heads) and the "age of steel," which was truly startling.

The Blackfoot Project begins with Lower Two Medicine Lake, located partly in the southeastern corner of the Glacier National Park. A storage dam, now under construction, will convert this lake into a reservoir of about 854 acres area and capacity of 16,000 acre-ft. Two other storage reservoirs, with combined capacity of nearly 90,000 acre-ft., are contemplated. The possible development is 122,000 acres, of which 17,000 are now developed, served by 34 miles of main canal, 75 miles of laterals and sub-laterals. Fifty Indian laborers and as many Indian teams are working at Two Medicine Dam.

### Flathead Project

This project has some unique features. The collecting canal starting at the southeastern corner of the Reservation on the Jocko River Drainage as a source is being dug 55 miles northward parallel to the Mission Range terminating in the Twin and Pablo Reservoirs just south of Flathead Lake. It is noteworthy that this canal excavation is entirely by steam shovel, principally as one-bank canal, and at a cost of only 20c. per cu.yd., all overhead charges included, the material being a large per cent. of rock.

The interception of the mountain feeders is accomplished with singular economy and simplicity. The stony beds of the mountain streams are so far settled and permanent that the canal is allowed to enter them directly. Then on the opposite side of the stream a strong timber crib, rock-filled, is built slightly inclined into and down the stream like a jetty. In this suitable plank gates are fixed and in front of these an excavation of sufficient depth is made for a pool, so that by proper setting of the gates the required amount of water may be taken into the canal which continues on from this crib abutment.

In the discharge of the canal into the stream from Lake McDonald, which the writer visited, not a particle of concrete was used. The banks of the stream and canal in the vicinity of the pool are protected by heavy paving obtained close at hand, and the whole cost is said to be only about $1000. This is real "engineering"—works entirely safe and sufficient made with materials on the spot and adapted to the situation.

Flathead Lake, 25 miles long and 12 miles wide, resembles a Swiss lake in scenic beauty. The area of this lake is 107,000 acres, and its annual regimen, unregulated storage capacity, 1,800,000 acre-ft.; tributary drainage area, 8000 sq.mi. As the north line of the Indian reservation cuts the lake nearly into halves, the full possibilities of this as a storage reservoir cannot be realized unless the rights of many riparian owners around the northern half are extinguished.

The regulation ultimately proposed contemplates building the monumental Newell dam (concrete) three miles below the lake outlet, with a height of 180 ft. above the stream bed and spillway of 1000 ft. length hewn from the rock formation on one side. A tunnel 1934 ft. long, completed almost to piercing the base of the point which will form one abutment of the dam, will serve to relieve the coffer-dam and partly unwater the bottom during construction of the dam; later to deliver the water for generating the power which will be used to pump water for irrigating land on the south and west sides of the lake. Four other dam sites have been selected in the course of about 40 miles of the gorge below the lake. There are 15 other storage reservoirs planned on the reservation with an aggregate additional capacity of 148,000 acre-ft. Total area to be irrigated 152,000 acres in seven divisions; average elevation 2800 ft. The works so far completed will serve 40,000 acres.

### Administration of Reclamation Projects

The importance of some minor details of administration in promoting the smooth working of daily routine and ultimate success of a large work are not always fully appreciated by contractors as a class. In the northern division the Supervising Engineer, in endeavoring to control all conditions which tend to efficiency, has made the following requirements among others:

The buildings of the project headquarters (always plain wooden structures, built at least cost consistent with the requirements of hard usage) shall be kept neatly whitewashed, the grounds effectively fenced, and the premises maintained scrupulously clean and neat, conforming to the requirements of modern sanitary standards. Demonstration gardens must be cultivated at the "project" and "feature" headquarters to provide not only fresh vegetables and fruit for the table, but to give object lessons by contrasting crops raised with and with-

Fig. 8. Headworks of Two Medicine Canal, Blackfoot Indian Reservation Project

out irrigation. On the lower Yellowstone project a garden of three acres provided such abundance of fresh products that the problem of holding restless laborers was solved because they could not find such wholesome and attractive board anywhere else. The extra cost of these gardens is very small, because the work is done by the stablemen or other help when not otherwise employed.

In the wholesale purchase of supplies, tinned goods are bought sparingly, but dried fruits freely. It is ordered that a pig shall be kept by or for each employee. At the St. Ignatius headquarters in the Flathead Project, 175 head of hogs were issued as meat to the messes at 9½c. per lb., and since these consumed much of the waste, the feed and other expenses did not cost the government over $2 each.

For the purpose of facilitating study of the questions under consideration, the Supervising Engineer issued invitations for an "Operation and Maintenance Conference," at Helena, Mont., Dec. 14 to 16, 1911. Programs were sent to 70 officials and others representing a variety of interests. This was attended by 51 supervising and project engineers and others of the United States Reclamation Service, officials of the United States General Land Office and Geological Survey, the Lieutenant Governor of the State, representatives of the State Agricultural College, of numerous private irrigation companies and Water Users Associations, etc. Ten general topics were proposed for discussion, ten committees appointed to manage the discussion of certain important questions, eight valuable committee reports were submitted, and twenty-four short papers were presented and discussed.

As indicative of the nature of the questions claiming the attention of such a conference, we may mention a few as follows: Economic Location of Onebank Canals, a neat geometrical solution; Location of Lateral Canals; Delivery of Water, Rotation or Continuous; Seepage from Canals and Prevention; Elements Essential to Success of Settlers on Reclamation Projects (three papers); Drainage; Contracts; Qualifications Requisite for an Operation and Maintenance Employee; Government Messes, their regulation, Requirements and Costs (two papers). The latter presented some very interesting data and statements.

Nine of these papers were presented by project engineers, four by superintendents or managers of irrigation, three by assistant and junior engineers, four by chief clerks and project examiners; and three by representatives of Water Users Associations.

It has been said of the engineers of the Reclamation Service in general that they are a band of enthusiasts. Whether or not this is intended as a mild reproof, it is certain that, as regards the Northern Division, a visiting engineer who spends a few days among them in their camps and going over their work, cannot fail to admire their loyalty and devotion to a great work.

They are working out their problems with great efficiency, *esprit de corps* and economy. Generally away off in the wilderness of plains or mountains, with little or no congenial society, where their works cannot be "seen and known by al' men," not appreciated and often misunderstood and misjudged by those with whom they have to deal, usually "unpraised and unsung," they are sturdily and faithfully trying to do their level best, and have accomplished results which are forcing recognition from a careless world.

## Autocementation, and the Freezing Test of Stone

In the course of an investigation of Canadian building stones, some peculiar observations were made in connection with the freezing test. In particular there was noted an occasional gain in strength as a result of the freezing test, and what appears to be a cementing action of the particles of the stone. The Department of Mines of Canada is making a complete reconnaissance of Canadian stone resources, and Vol. 1, covering the southern part of the province of Ontario, has just been issued by the department. William A. Parks prepared this report. Most of the stones were tested, and in this work the observations in question were made.

The freezing test which was applied to the samples of stone is described in the report (p. 66) as folows:

> A 2-in. cube was carefully prepared and dried in the air bath at a temperature of 110° C. for 24 hours, after which it was allowed to cool in a desiccator and was then weighed. The cube was then saturated with water under reduced pressure for 36 hours, after which it was exposed to 40 alternate freezings and thawings. The specimen was again dried in the air bath, and crushed in precisely the same manner as the unfrozen samples of the same stone.

The freezing test in this form is not considered by Mr. Parks to be entirely satisfactory, as the soaking in water is likely to make the stone contain very much more water than it would contain when ordinarily exposed to the weather, and therefore the conditions of the freezing test are not closely parallel to natural conditions. On the other hand, to make a freezing test on stone when containing only a normal amount of water was regarded as impracticable because its moisture would be so low as to require a very great number of freezings and thawings to give appreciable results. In default of something better the above described method was adopted. It is thought to give results of only very approximate value, i.e., the figures obtained from the freezing test should not be interpreted directly as a gage of the weather-resisting or freezing-resisting power of the stone.

The following remarks on the general results of this freezing test are given:

> In the case of granites, gneisses, crystalline limestones, and marbles, there was a uniform loss of strength, but in the case of the limestones and sandstones, while the majority of the specimens lost in strength, there were some which increased to an appreciable degree. As there could not well be an instrumental error to account for the high result of the frozen specimens, new cubes were made of the stones in question and the crushing strength of the unfrozen sample again determined with the greatest nicety possible. In every instance a result nearly identical with the original test was obtained, so that we are forced to conclude that, in some cases, stone actually increases in strength by being subjected to the operations described.
>
> It is not to be inferred that the freezing and thawing has produced this result; the explanation more likely lies in the heating and drying. An increase in strength after freezing has been recorded by various authors, but it has generally been attributed to lack of care in preparing the material. Buckley evidently considered such results anomalous, for he explains them as due to imperfect cubes or to the manner of operating the testing machines. Merrill gives a table in which 5 stones out of 15 increase in strength, but he does not offer any explanation of the apparent anomaly.

Mr. Parks explains the phenomenon as being due to the formation of fine fragments in the interior of the stone as a result of solution and the disintegration due to freezing and thawing, followed by a subsequent recementation of the fine particles. He has actually observed this cementation as follows:

> At the time the old lithographic quarries near Marmora, Ont., were in operation, the fine dust obtained in working the stone was barreled with the intention of using it as a polishing material. Several of these barrels were left in the mill, and by the simple process of becoming damp and drying out, protected from both sun and rain, the contents have been converted into a solid mass rivaling the stone itself in hardness.
>
> Two specimens of almost identical appearance, one of which gained in strength under freezing test, while the other lost materially, were reduced to powder, wetted, raised to a temperature of 100°, again wetted and allowed to soak for a few hours. On being raised to a temperature of 110° C., the pellet obtained from the stone which gained in strength showed a very much greater coherence than that from the other.

Elsewhere in the report, in giving the detailed description of the Marmora quarries, the author says (p. 225):

> It is an interesting fact that the shavings from the planers if wetted and allowed to stand, set to a cement of considerable strength.

The relation of this observed cementing of the stone powder to the result of the freezing tests is summarized by the author as follows, with an observation also on the effect upon strength of wetting the stone:

> If it should be definitely established that the operations of drying, freezing and thawing, and again drying, tend to raise the crushing strength of certain stones, it follows that the recorded loss of strength does not really represent the loss due to freezing, but that loss less an increase due to the resetting of the disrupted particles.
>
> In this connection may be mentioned the fact that most of the sedimentary stones lose appreciably in strength on being wetted; this loss of strength is due to the softening of the cementing material, which holds the grains together. On again drying, the stone assumes its original hardness and coherence.

# Sanitation and Safety of Street and Steam Railways*

## Sanitation of Street Cars

By J. C. Halleck†

It would appear that heating and ventilating are two of the most important factors of perfect sanitation of street cars. Undoubtedly closely correlated themselves, upon the combined system adopted to procure efficiency along these lines must depend the final result of true sanitation. Too much stress has been put upon ordinary washing, cleaning and disinfecting of the cars. If a proper ventilating system is not adopted, cleaning is of only very temporary benefit. Perhaps the general misunderstanding of what constitutes sanitary conditions in a car is due mostly to the efforts of railway companies to comply with local municipal ordinances on the subject. These regulations are often written and made laws by men who have little or no knowledge of the subject, and whose principal aim is to maintain a comfortable but unsanitary, temperature in the car. Some do reach the point of requiring that the car shall be cleaned at certain specified periods, but do not define just what this cleaning shall be. Some have demanded the use of disinfectants, but in nearly all cases, this seems to have either been discontinued, or to have become a very perfunctory performance.

After having adopted a satisfactory system of heating and ventilation, it would appear that the most reasonable form of sanitation is that which is the most simple, i.e., the daily, or semi-daily, sweeping of the car with the subsequent removal of as much dust as possible with a vacuum cleaner, these operations to be followed by the use of a damp cloth on seats, backs, window sills and frames. If the seats and backs are upholstered, the vacuum cleaner does away with the necessity of a damp cloth on these portions. Then with a thorough washing by hose, inside and out, at least once a week, a practical sanitation should have been accomplished that would satisfy all, except the extremists on the subject. The results obtained from the use of disinfectants are too temporary in their benefits to be of any practical worth.

Is it not possible that in designing new types of cars too much attention has been given to the rapid handling of passengers and their supposed comfort, rather than to make the car perfectly accessible for thorough cleaning? As an example, how can a car be swept as it should be, when under every seat you find a fixed foot rest only a few inches above the floor? This, of course, refers to those cars having seats facing forward, as in a railway car. In many cars we still find the slatted or grating floors, a standing temptation to the daily cleaner to sweep without removing the grating. How many inaccessible nooks and sharp corners could be rounded out or eliminated, if the designer gave sufficient thought to the future cleaning of his product.

Let the designer and the sanitarian work together to give us the best practical results along these lines.

*Official abstracts of papers read before the International Congress on Hygiene and Demography, Washington, D. C., September, 1912.

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## A Further Study of the Ventilation of Sleeping Cars (The Steel Car)

By Dr. Thomas R. Crowder*

Two years ago the author presented a study of the ventilation of sleeping cars, in which an attempt was made to determine the amount of fresh air which enters the running car under various conditions of operation, the places of entrance of the air, its distribution, and the general direction of its currents. Two plans of ventilating were considered: The natural or deck-sash method, and ventilation by exhaustion.

The proportion of carbon dioxide in the air of the cars and the number of occupants were used as the basis for computing air supplies; and the course of air currents, etc., was traced through determination of the contamination of the air with the products of respiration as represented by carbon dioxide. Analyses of the air were made by the Petterson-Palmquist apparatus.

Since the completion of that work the steel car has come into extensive use in this country. These cars are all ventilated by the exhaust method, and they have some minor changes of construction tending to increase the volumetric air supply. Following the method previously employed a study of 36 cars has been made involving the analysis of some 1400 samples of air. The comparative results show that the volumetric air supply, as indicated by the $CO_2$ determinations, is actually somewhat increased over that of the older type of cars similarly equipped as to ventilating devices.

It was determined that the older type of car, ventilated by the natural or deck-sash method, receives an average of about 28,000 cu.ft. of air per hr.; the same car ventilated by the exhaust method about 41,000 cu.ft. per hr.; and that the steel car receives about 53,000 cu.ft. per hr. The air supplies to the lower berth are, respectively, about 1400, 2000 and 2200 cu.ft. per hr.; and to the upper berth, respectively, about 1300, 1900 and 2000 cu.ft. per hr. The air supply, under the influence of exhaust ventilation, finds its way in chiefly through crevices about doors and windows, and is very evenly distributed throughout the car.

*Chicago, Ill.

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## The Accident Problem of the Railroads

By Dr. Francis Denison Patterson*

The accident problem of the American railroads is more serious than in other countries, for here the demand of the public is for speed, and this over tracks which are not in all cases properly guarded. The problem is serious not only by reason of its accompanying mortality, but also because the accident account is an operating expense of material amount.

An analysis is made of the reports of the Interstate Commerce Commission and attention called to the increase in recent years of the number of persons who are injured in accidents and stress is laid upon the great increase in the number of employees who are injured.

Attention is called to the fact that all accidents are due to some one of three causes: (1) a defect in material; (2) its failure to work properly, and, (3) the failure, sometimes of employees and sometimes of the injured person, to take the proper care.

Attention is called to the difficulty in providing proper equipment and maintaining it at the highest standard because of the attitude of the government on the question of rates.

This plan of accident prevention deals solely with the third cause and it applies equally to the employee, passenger, and the public in general.

First, as regards the employee: Proper care can only be taken by an employee who is physically and mentally competent and this can only be determined by a physical examination by a physician. This should comprise a complete test of the applicant's physical and mental condition and the form for such an examination is given. Examination should be thorough. A "trainmaster" or "air-brake inspector" is not competent to make a proper physical examination. It should be criminal to employ any man in the operating department of any railroad without first submitting him to a complete physical examination, and these examinations should be repeated at a yearly interval and after any absence from duty for a period of three days or longer by reason of either illness or accident. Attention is called to the relation of fatigue to efficiency and the necessity for proper mental and physical rest after the hours of work. No employee should be on duty for more than twelve consecutive hours, and this should be followed by at least eight consecutive hours of rest before again returning to duty.

*Chief Surgeon, Philadelphia & Western Ry. Co., Philadelphia, Penn.

Second, the passenger, and third, the public in general: It is the duty of the railroads to impress upon both of these classes by publicity the necessity for care upon their part in helping to prevent accidents. All trespassers should be vigorously prosecuted. Whenever a personal injury case occurs it should receive medical attention at the earliest possible moment. All employees of the operating department should be instructed in the principles of "First Aid" and should carry an "Emergency Packet."

## Legal Provisions for the Restriction of Alcoholism Among Employees of Common Carriers in the United States

By Dr. Reid Hunt*

More than thirty states have laws placing restrictions upon the employees of railways and, to a lesser extent, upon those of other transportation agencies in regard to the use of intoxicating liquors. Most railways have regulations on this subject in addition to the legal regulations. The character of the restrictions varies considerably: in a few states total abstinence is required; more frequently intoxication on duty is made a misdemeanor.

In some states the railway and other transportation companies are prohibited under various penalties from employing persons addicted to the excessive use of intoxicating liquors.

## The Necessity for the Maintenance of Sanitary Departments by Common Carriers and the Duties that would be Performed by those Departments

By Dr. Arthur M. Hume†

The strength and stability of a nation depend largely upon the physical well-being of its citizens. Measures which promote and conserve the health of the people are essential to the perpetuation and growth of nations. The *devising* of health-promoting measures is only one problem of sanitation; another and often a greater problem is the practical application of such measures to the alleviation of existing unhealthful conditions.

Science and modern invention have produced appliances and methods which insure to house dwellers, even in large cities, a plentiful supply of good water, good air, reasonably clean food, and the removal of noxious waste and excreta; and he who is not a house dweller but lives in the open has but to help himself from Nature's bountiful supply of all that man requires for existence. Few of these salutary measures have been applied to the protection of the railway-traveling public, otherwise our "World on Wheels"; and many of these measures are not applicable or practicable until made so by special work along the line of the sanitary problems involved in railway transportation. It is in railway coaches that a large percentage of our people live; they eat, and drink, and sleep there: some are born there and many die there. If their health is to be conserved, then equally good sanitary conditions must be maintained in railway trains as in private and public houses of the best class. Modern appliances and methods will furnish to the 200 guests of a public house or hotel a plentiful supply of good air of proper temperature, good water, pure, well kept and well cooked food, and a safe disposal of waste and excreta by proper sewerage or other methods. Sanitary science has not yet solved the problem, howevr, of furnishing to the 200 occupants of a trans-continental railway train, flying across the face of the earth at 50 miles an hour, subject to the greatest variations of altitude, temperature and humidity, an always proper supply of air, an always pure water to drink or pure food to eat, and particularly an ideal method of waste disposal.

There are also the problems of car cleaning and the maintaining of cleanliness in cars and car equipment, stations and roadway; the transportation of the sick with the well, safety devices and measures for the protection of life and limb of passengers.

A scientific, practical sanitarian who has added to his sanitary knowledge a working knowledge of car building, roadway maintenance, motive engineering and traffic operation is needed to solve these problems of railway sanitation. Every railway of consequence should maintain a well-equipped Sanitary Department in charge of a competent railway sanitarian.

*Washington, D. C.

†Chief Surgeon, Ann Arbor R.R., Owasso, Michigan.

## Food, Water and Ice Supplies in Railway Stations and on Railway Trains

By Dr. S. J. Crumbine*

The problem of feeding and watering the traveling public, numbering millions per annum in this country is one of gigantic proportions; dining-car service presents certain mechanical difficulties preventing ideal conditions. Refrigerators are improperly used because of crowded conditions.

The main body of the paper is taken up with a report of investigation of the water-supply furnished on Kansas trains which is summarized as follows: There were 78 samples taken from trains, and in order to simplify matters, these have been re-arranged into four groups according to the degree of pollution, beginning with the worst samples in group one and ending with the purest water in group four. Group one includes all of those samples having at least 10 colon organisms in 10 c.c. of water or 1 per c.c. of water examined. Group two includes those having from 6 to 8 B. coli in 10 c.c. of water. Group three: There are 14 samples having from 1 to 4 B. coli per 10 c.c. of the water. In two of them both streptococcus pyogenes as well as B. coli was present. Group four: There are 49 samples in which no B. coli were present in 10 c.c. of the water.

In group one there are five samples or 6.4% containing 10 colon bacteria in 10 c.c. of the water, or 1 per c.c. with bacterial counts ranging from 500 to 1800 per c.c. In one sample B. pyocyaneus was found to be present. Waters in this group are decidedly unfit for drinking purposes. In group two there are 9 samples or 11.4% in which there are 6 to 8 colon organisms in 10 c.c. of the water, with the bacterial count ranging between 400 and 1200 per c.c. These waters are open to strong suspicion and should not be drunk. In group three there are 14 samples or 17.8% having from 1 to 4 B. coli in each 10 c.c. of the water with comparatively high counts.

Of the 49 samples in which no B. coli was found, 22 of them or 44.9% show counts developing at body temperature of over 350 bacteria per c.c. and 18 of these have 500 or more bacteria per c.c. Thirty-one samples show counts under 500 per c.c. and of these 27, or about one-third of the total number of samples examined, are under 350 per c.c. That is, if we attribute any significance to the number of bacteria developing at the body temperature, and adopt even 350 per c.c. as a dividing line between clean and dirty water, we find that of the 78 samples examined, only 27, or about one-third, showed themselves to be sufficiently clean for drinking purposes.

*Secretary, Kansas State Board of Health, Topeka.

## The Sanitation of Railroad Construction and Railroad Repair Camps

By Dr. T. D. Tuttle*

The unsanitary conditions existing in railroad camps bear closer relation to public health than is apparent from the surface indication. These camps are located immediately on the right-of-way of public carriers and when possible, immediately upon the banks of a water course, thus furnishing infection both through the medium of flies and air and the water becoming contaminated from the camps. In the study of these camps, the first element with which we have to deal is the character of the men employed. These men are usually dirty in person and dirty in habits and to attempt to teach them cleanly habits is a task well nigh impossible. We must therefore

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look to the head of the camp, preferably the head contractor, to see that sanitary conditions are maintained in such camps.

That these camps are extremely frequent sources of typhoid infection everyone who has studied them fully realizes. We have traced repeated outbreaks of typhoid fever to such camps and from this source of infection, typhoid has spread to adjacent districts. The disposal of human excreta in railroad camps and in fact in all domestic camps, is as important as the disposal of excreta from a city. In connection with the disposal of excreta, comes the question of protection of the food supply from contamination. Even in the best regulated camps, some of the ignorant employees are apt to violate the sanitary requirements and furnish infection for the food of the whole camp unless this food is properly protected from fly contamination.

The water supply in the camp is, of course, a matter of great importance directly to the employees. How frequently we find the common camp toilet located on the bank of a stream above the point from which the cook takes water for washing vessels and for general domestic purposes. The matter of protecting the water supply for the camp is of importance, not only to the employees but to the public at large, for through the pollution of the water supply at the camp the water furnished to many of the cities becomes contaminated.

All of the conditions and dangers that relate to railroad-construction camps apply with equal force to railroad-repair camps, in fact repair camps are more directly in the line of travel than are the construction camps.

The keeping of railroad camps in a thoroughly sanitary condition is of benefit to not only the public at large but to the contractor himself.

At a meeting of representatives of Boards of Health, Railroad Commissioners and Railroad Operative Departments, held in Helena, in March, 1912, a set of regulations relative to railroad camps were drafted. These regulations have been adopted by the State Board of Health of Montana, and go into effect Oct. 1, 1912, and we believe that if these regulations are strictly enforced, much of the disease resulting from these camps will be eliminated from our state.

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**The Grand Trunk Pacific Ry.** has been completed to Tete Jaune Cache, 60 miles west of the summit in the Yellowhead Pass (on the west slope of the Rocky Mountains) and 1100 miles west of Winnipeg. It is hoped to have the grading completed for a further distance of 120 miles (to the second crossing of the Fraser River) by the end of 1912. From Prince Rupert, the Pacific Coast terminal, the line has been completed east as far as South Hazleton, 180 miles. It is expected to reach the Bulkley Summit, 275 miles east from Prince Rupert, in the spring of 1913. There is still an insufficient supply of labor on construction.

## Automatic Car-Bumpers and Barriers for Drawbridge Approaches

The effective blocking of tracks and roadways on drawbridge approaches while the draw is open is a highly desirable and important feature in order to prevent accidents, but comparatively little has been done in developing or introducing devices for this purpose. Reliance is placed largely, as a rule, on simple gates (which serve as warnings rather than as stops) supplemented by audible or visual signs, while railway (and sometimes street-car) tracks may have derails. The bascule type of drawbridge forms an effective stop and barrier when raised, but with single-leaf spans there is still one open end, while even at the other end some guard is needed when the bridge is rising. Furthermore, it would not be desirable to let the span take the shock of a runaway wagon or street-car. An automatic car-stop or bumper for tracks and an automatic barrier for roadways have been invented by J. B. Strauss, of Chicago, and these two devices are described below. They are applicable to drawbridges of any type.

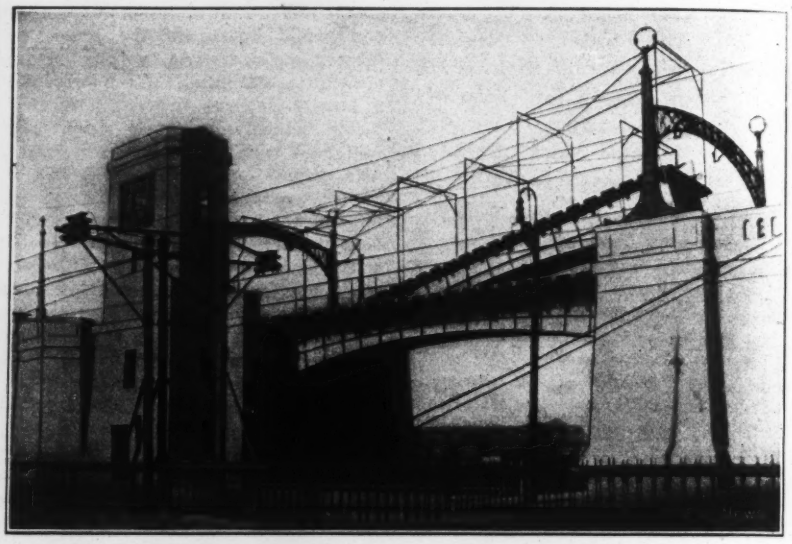

FIG. 1. DRAW-SPAN OF THE CHARLES RIVER BRIDGE; BOSTON ELEVATED RY., BOSTON, MASS.

(Approaches equipped with automatic car-bumpers, which are thrown into position when the bridge is open).

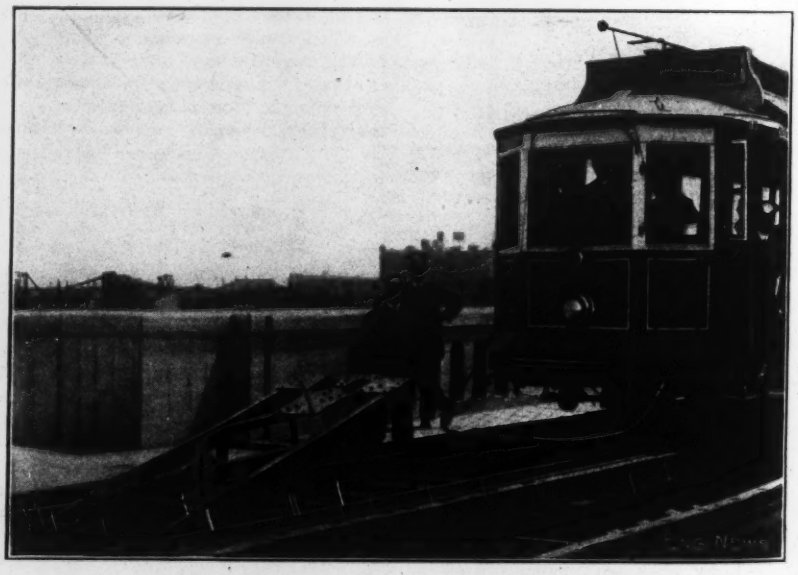

FIG. 2. CAR BUMPER RAISED; CHARLES RIVER BRIDGE

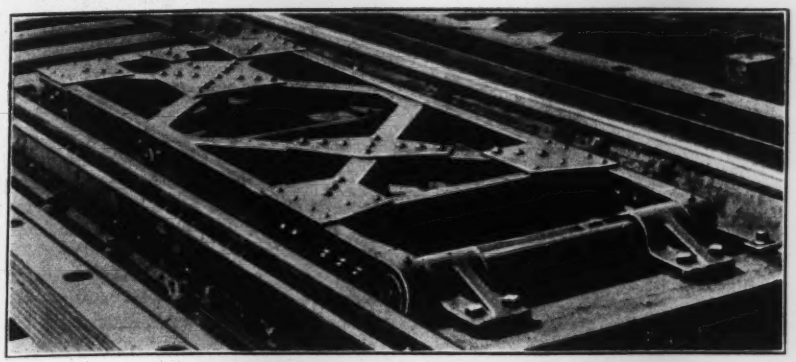

FIG. 3. CAR BUMPER LOWERED; CHARLES RIVER BRIDGE

## AUTOMATIC CAR-BUMPER AT THE CHARLES RIVER BRIDGE, BOSTON, MASS.

The East Cambridge extension of the Boston Elevated Ry. crosses the Charles River by a bridge 1700 ft. long, consisting of a series of reinforced-concrete arches and a 70-ft. single-leaf bascule span of the Strauss type. The draw is a plate-girder deck structure, the bottom chords being curved and the bridge being painted a light gray in order to harmonize with the appearance of the concrete spans. It is a double-track bridge, but each track is carried on a separate structure, so that in case of repairs or renewals being required on the span or the machinery, or in case of one track being blocked, one side of the bridge might still be available for service. Fig. 1 shows the draw with one half of the leaf closed and the other partly opened. The trunnion bearings are supported on fixed girders placed beneath the floor, and the leaves are counterbalanced by pivoted concrete counterweights. The leaves are operated by two 40-hp. d.-c. motors, connected through separate trains of reduction gears to the operating pinions, which engage with curved racks on the bottom chords of the tail ends of the girders. The two sets of machinery may be operated separately or together. Emergency hand-gear is provided also. The bridge was designed by the Strauss Bascule Bridge Co., of Chicago, and built by the Pennsylvania Steel Co., the entire work being under the direction of G. H. Kimball, Chief Engineer of the Boston Elevated Ry. Co., and C. S. Fernald, First Assistant Engineer.

To insure safety to traffic while the bridge is opened it is equipped with two of the bumpers mentioned above, these being at opposite ends of the bridge, one in each track and about 30 ft. from the draw. It is considered that these will not only effectually stop any cars which might run against them, but that their presence will tend to make motormen particularly careful in obeying the signals and stopping their cars at the proper place.

The bumper consists of a structural steel frame pivoted to a horizontal shaft carried in bearings bolted to one of the ties. By means of rods worked from a train of gearing below the track, the free end of the frame can be raised to the level of the bumper beam of the cars, the frame being then at an angle of about 20° above the horizontal. This raised end faces the approaching car, and is fitted with a car-spring buffer and a red lamp. Figs. 2 and 3 show the bumper in raised and lowered position, respectively.

The operating mechanism is shown in Fig. 4. It is driven from a 2½-hp. motor, and is interlocked with the signals and the bridge-operating machinery, so that the bumpers are raised to the stop position before the bridge can be opened, while the bridge must be closed and locked before they can be lowered to enable cars to pass. When the bridge is to be opened, the operator first displays a red signal on each approach, indicating the point at which cars must stop. He then operates the mechanism of the bumpers and the end-locks, and when these movements are completed he can open the bridge. When the bridge is again closed and locked, the bumpers are lowered, and the stop signal released to permit cars to move.

The operator's tower is of concrete and has three floors. The lowest contains the operating motors, the second the hand-operating device, and the third (in which the operator is located) contains the switchboard, controllers, etc. A 3-hp. motor operates the locks at the front end. Automatic cut-offs are provided, which throw the circuit-breakers and cut off the current from the operating motors and set their brakes when the bridge is almost completely open. Signal lights in the operator's room indicate the successive positions of the locks, bumpers and bridge. The controllers for the operating motors and the bridge-locks motor are electrically interlocked in such a manner that the operating motors cannot be started as long as the locks are set. On the other hand, it is impossible to throw

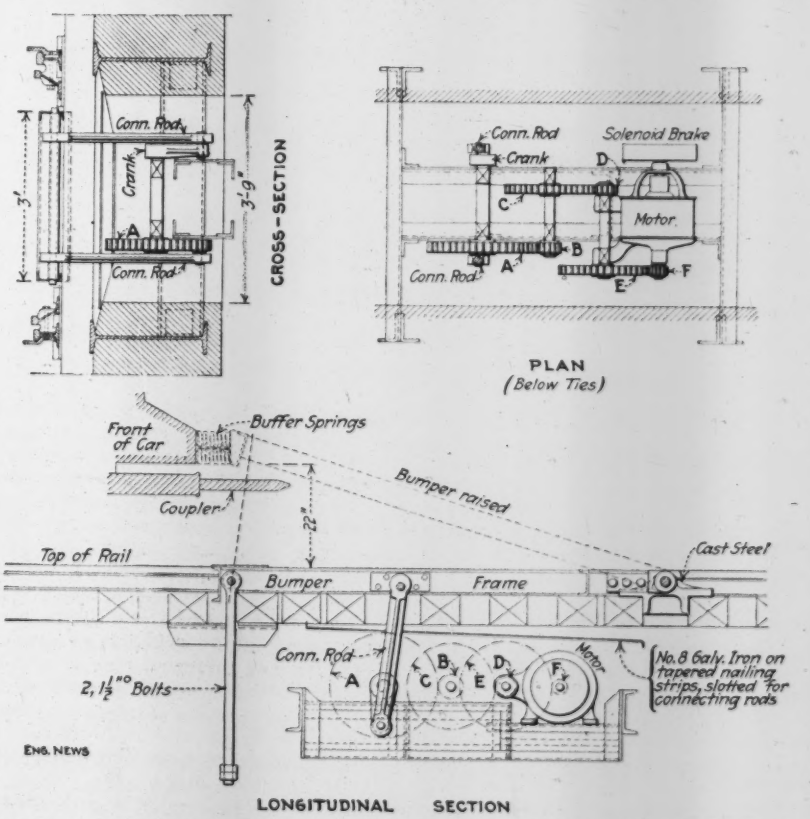


FIG. 4. OPERATING MECHANISM OF CAR BUMPER ON THE CHARLES RIVER BRIDGE; BOSTON ELEVATED RY.

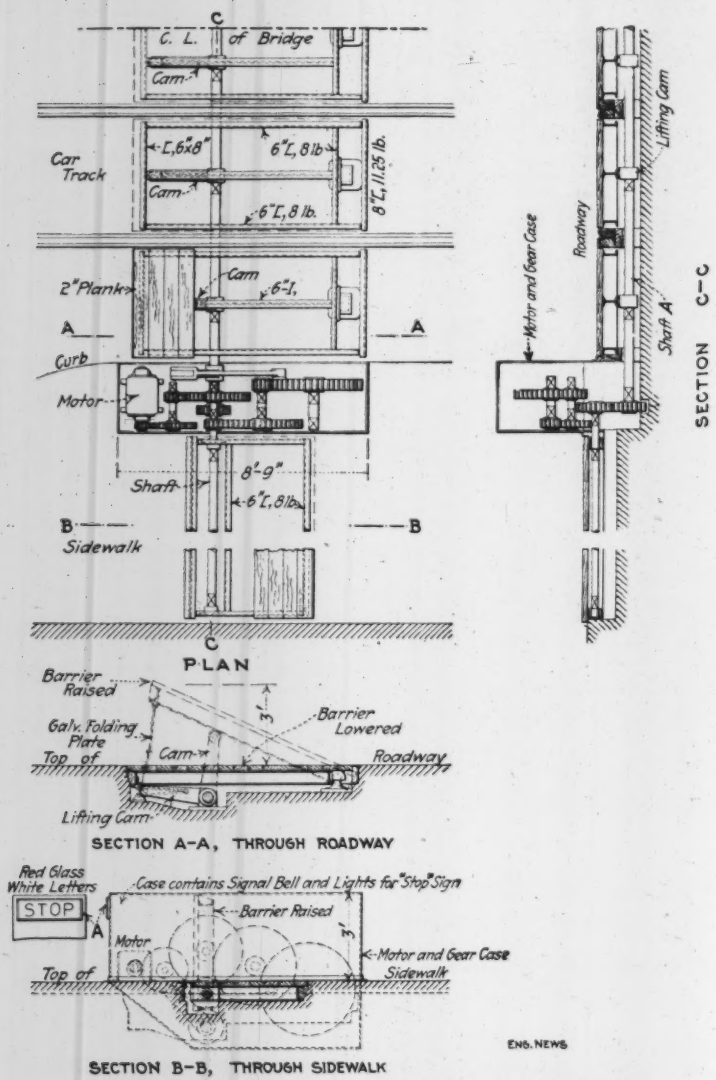


FIG. 5. BARRIER FOR CLOSING THE ROADWAYS AND SIDEWALKS OF APPROACHES TO HIGHWAY DRAWBRIDGES

the locks until the closing bridge has completed its travel and come to a bearing. The bridge is interlocked with the railway signals and no current is available for its operation until the signals have been set at "stop"; and the signals cannot be set at "proceed" until the bridge has been closed, the locks driven and the bumpers lowered. The time consumed in raising or lowering the bumpers is about ten seconds.

### BARRIER FOR HIGHWAY BRIDGES

The general principles of the car-stop described above have been applied in the design of a barrier to effectively close the roadway and sidewalks of a highway bridge, as shown in Fig. 5. The barrier in the roadway consists of a platform which in its normal lowered position forms a portion of the street pavement on the approach. This is pivoted to a cross shaft, and is made in sections which are separated by the track rails, which are left undisturbed. When the bridge is to be opened, the platform is raised to an inclined position, facing the traffic, in the same manner as the car bumper. A folding curtain of sheet iron closes the space under the raised bumper and prevents persons and horses from stepping into the shallow pit. The depth of this pit is only 9 in., increased to 14 in. at the shaft. The sidewalk barrier is somewhat different, however; the platform swings in an opposite direction and through an angle of 90°, so as to stand in a vertical position. It will be seen that the platform pit in this case is on the far side of the barrier, so that persons cannot get their feet caught as the platform drops. The gearing is inclosed in a casing, which in the design illustrated is located at the edge of the sidewalk. This contains a signal bell, and at the end facing the traffic is an illuminated sign lettered "stop." Thus the device includes not only a positive stop or barrier, but also audible and visible signals.

The operating mechanism of the barrier is interlocked with that of the bridge. The first movement of the operator starts the bell and shows a red light at the danger sign. The next movement simultaneously withdraws the bridge locks and raises the barrier. The third movement operates the bridge. In closing, the bridge is lowered, then the locks and barriers are operated, and finally the signals are released.

## The Current Meter Rating Station at the Irrigation Office, Department of the Interior, Alberta

At the Oct. 10 meeting of the Canadian Society of Civil Engineers, a paper on the above subject was read by F. H. Peters, A. M., Can. Soc. C. E., and the following abstract is taken from Mr. Peters' description of the Canadian station, several features of which are similar to those of the Bureau of Standards Station, at Washington, D. C.

For a number of years stream-measurement work has been carried on in the provinces of Alberta and Saskatchewan by the Department of the Interior, and since 1909 particular attention has been paid to making these observations systematic and extensive.

During the early years of the work, a current meter-rating station was established on Bow River, at Calgary, Alta., but this was poorly equipped and fell into disuse. Finally in 1910 plans and specifications were drawn up for a modern installation, and this was completed on July 21, 1911, at a total cost, for station and equipment, of $4475.

In designing the work the aim was to gain the most perfect apparatus possible for rating the current meters, and to create a permanent structure, so that it was early decided to use concrete in the construction of the tank.

This tank was a necessity because no stretch of still water was available, and in planning it two main points had to be considered. First, it had to be free from leaks, as the water-supply was to be drawn from the Calgary city mains and the municipal authorities were unwilling to undertake to replace leakage losses from the tank. Second, the cross-section was required to be as small as possible, to reduce the cost of the installation, and still it had to be made of sufficient area to eliminate any following movement of the water, in running meters through the tank.

To overcome the first difficulty, a

heavily reinforced structure was designed such that, on being emptied and exposed to sun and frost, no temperature cracks would develop, and the inside faces of the tank were water-proofed by the Sylvester process. No data were available for the proper design of the cross-section, but the dimensions finally decided upon have proved entirely satisfactory.

FIG. 1. METER RATING CAR IN MOTION

The concrete tank is 250 ft. long (with provision for a future extension to 500 ft.) and is 6 ft. wide and 5 ft. 6 in. deep. The floor and walk are 8 in. thick and heavily reinforced, longitudinally and transversely. Two coats of Sylvester's wash were applied as waterproofing and, though exposed on two occasions to temperatures of —30° F., no cracks have developed and the tank is absolutely water-tight.

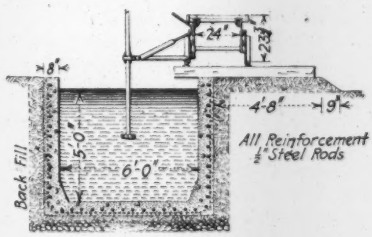


FIG. 2. CROSS-SECTION OF METER RATING TANK, CAR AND TRACK

The design of the car, which is the main feature of the station, is borrowed in part from the car in use by the U. S. Bureau of Standards, at their Washington, D. C., station. The axles run in roller bearings and the platform is attached to the front axle by a pinion joint, which makes the level of the platform depend entirely on the rear axle, and overcomes any twisting tendency due to uneven tracks. Two horizontal iron arms project from the car over the tank and hold the meter suspension rod during calibration tests. Switch handles project out from the side of the car opposite the tank, and these are operated by two fixed upright posts, 200 ft. apart, which are erected beside the track. The car platform carries two wheels which run on trolley wires and are used in making the electrical connections for timing and for counting meter revolutions. The original design of the car contemplated the use of an electric motor drive, and such a motor can be placed on the rear axle at any time, but the lack of a proper control mechanism for constant speed drive has so far prevented the use of electric power, and instead the car is pushed by hand.

The track, along which the car runs, is

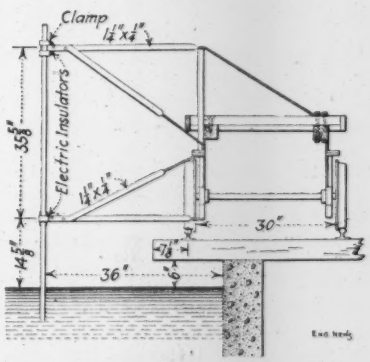


FIG. 3. METHOD OF SUSPENDING METER FROM CAR

of 16-lb. rails, laid to a gage of 32⅜ in., on 4x6-in. ties, fish-plates and bolts being used at each joint. Particular care was used in laying the track to get it as solid and level as possible, and with rail joints as close as possible, so that the car might run smoothly in making tests.

All of the calibrating instruments are in the car-house at the end of the tank, and the car is kept in this house under lock and key, when not in use. Two electric circuits control the instruments for measuring the two important variables of time and meter revolutions. As explained above, the third quantity of interest in testing, namely, the distance, is constant for all tests with the present tank length, being 200 ft.

It may be well to say that the tests are made with the car running in both directions, and arrangement of the switches is made so that possible errors in one direction are corrected in the opposite direction. Two electric registers are connected in series for counting the meter revolutions, so that errors can be detected and reduced. The stop-watch timer is operated by a solenoid and padded lever, in exactly the same way that hand timing is accomplished.

The procedure in rating a meter is to make about 20 runs at various uniform rates of speed from 0.5 ft. per sec.—the lowest velocity on which the meter is usually employed—to 10 ft. per sec.—a velocity seldom exceeded in practical work. From the data thus gained, the revolutions per second with their corresponding velocities per second are computed, the points plotted, and, among them, the most probable curve drawn. From the rating curve thus constructed, the rating table for use in the field and office is prepared, showing in convenient tabular form the velocities corresponding to the various revolutions per second of the meter.

Some very interesting experimental work has already been done with this new equipment, along the line of determining the exact conditions which affect the operation of current meters, and the effects of constant use on such meters. It has been proved, contrary to expectations and to the judgment of experienced users of current meters, that, with a given current velocity, instead of running slower as a result of wear from long service, the almost invariable tendency is for old meters to run faster.

The value of this meter-rating station is intended to be increased by performing the calibration process on privately owned meters, in so far as such work will not interfere with the use of the plant for government work. For such service to private individuals, a small charge will be made, covering only the salaries of the necessary test men for the time they spend on this service.

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**Coal Production**—In 1911, the total world's production of coal amounted to approximately 1,300,000,000 short tons, of which the United States contributed 496,221,168 tons, or 38.1%. In the 12 years from 1899, when the United States first surpassed Great Britain, to 1911 the production of the United States has increased nearly 100%, while Great Britain has increased its output about 25%, from 246,506,155 short tons to 304,518,927 tons. The United States in 1911 produced over 60% more than Great Britain. Germany's production of coal and lignite in 1899 was 149,719,766 short tons; in 1911 it was 258,223,763 tons, an increase of over 70%. United States, Great Britain, and Germany produce more than 80% of the world's total supply of coal.

# The Design of Log Flumes

By J. P. Martin*

**For transporting logs from high mountain timber tracts to mills or railway lines in the valleys below, extensive use has been made in the far West of V-shaped timber flumes, into which the water from mountain streams is turned. Down these flumes the logs are floated to their destination. In the following article engineering principles are applied in the planning, design and construction of such flumes. It is the first attempt to apply engineering methods to this branch of industry and the article should be an invaluable aid to any engineer who may be responsible for installing such a system of transportation.**

*District Engineer, U. S. Forest Service, Ogden, Utah.

The following data have been prepared for the purpose of presenting to engineers and lumbermen some of the fundamental engineering problems involved in log fluming.

The writer has never heard of any discussion on the subject nor been able to find in any paper or treatise mention of the engineering problems involved. The treatment is therefore considered original. However, an exhaustive discussion and comparison of the different methods of logging and lumbering is not the purpose of this article. It is confined chiefly to engineering principles involved in fluming; with the aid of the diagrams, the feasibility of fluming can be determined in a general way. Other conditions which enter into the proposition, and to which no fixed rule can be applied, must be met on the ground in each specific case.

In the explanations of the various diagrams which follow, the data have been largely assumed at random, and in most cases the figures show little direct connection with each other. The diagrams give the relation between the various quantities upon which construction and operation depend. Given two quanti-

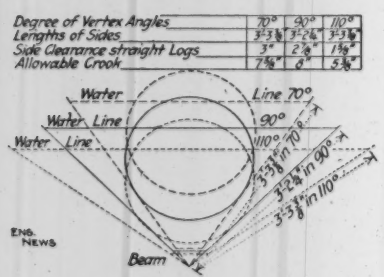



FIG. 1. A 24-IN. LOG IN FLUMES HAVING VERTEX ANGLES OF 70°, 90° AND 110°
(Weight of log, 4 lb. per ft. b.m.)

ties, a third can be determined from the diagrams without performing the mathematical computations. The diagrams are so related that with a few quantities known, the rest can easily be obtained.

A brief description of different methods employed in the West and a consideration of conditions under which fluming is the only practical method, may be applicable. To this end, the operations can be said to consist of two general steps—the transportation of the logs to the mill, and the transportation of the lumber to the market. Which one is the more complicated depends generally on the relative location of the mill. A number of flumes have been built in California, Washington, Montana, Idaho, and Wyoming for fluming logs to the mill or for fluming lumber to the market—depending on whether the mill is placed near the market or within the timbered area. In the latter the transportation of the lumber is the more important step; in the former it is the transportation of the logs. In some instances the market is 60 miles from the timbered area.

When the mill is located in the timbered area, the lumber is transported by wagons, by specially built railroads or by flumes. The first two have a large maintenance expense; the railroads and flumes a large initial cost. When the mill is located at a considerable distance from the timbered area, the logs are transported by wagons, by driving streams, by logging railroads, or by flumes. The first and sometimes the second has small initial cost. Logging railroads and flumes have a large initial cost, but the flumes require only a small maintenance expense.

When large streams are available, driving operations are often conducted. The method would be hazardous and often disastrous in many streams in California owing to the presence of rapids, huge boulders and box cañons. In the high mountains, where a considerable portion of the now available timber is located, the streams are small and driving is not feasible. The building of railroads is also impracticable, owing to the excessive cost of construction and to the steep grades. In such places flumes are used.

All flumes the writer has seen are of the character described—V-section. Sometimes the beam in the vertex is omitted. Its use increases the cost of construction but its advantages are obvious. It occupies space not needed especially in log flumes, makes a tight joint in the vertex, and avoids danger of jamming when the water is low.

A fluming system for logs consists of a main conduit with branches from supply streams and from different sections of the timbered area. A map of a system somewhat resembles a long crooked tree trunk with branches at the top.

## DEVELOPMENT OF DIAGRAMS

Fig. 1 shows the relations between flumes having different vertex angles. The angles taken are 70°, 90° and 110°. The log is, of course, the same diameter in each flume and the cross-sectional area of the water is the same. It is seen from the table with this figure that the 90° flume has slightly less length of side than the others, gives practically the same clearance to the log as the 70° flume, and nearly twice the clearance of the 110° flume. It also allows somewhat greater crook in the log than the 70° flume and a considerably greater crook than the 110° flume. Some sort of a timber stop is desirable in the vertex and it will be noted that with a 90° angle a square timber can be sawed diagonally in two for this place. The stop is also more easily and better fitted with a 90° angle than with any other. Such considerations show that a

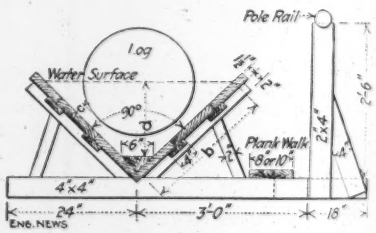
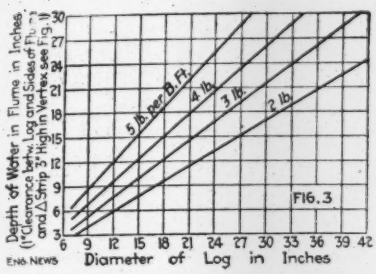



FIG. 2. CROSS-SECTION OF FLUME; MINES TIMBER CO., DEERLODGE NATIONAL FOREST, MONTANA

90° flume is the most advisable one to use. It is obvious that no other than a triangular flume need be considered since only logs are to be floated having a circular cross-section.

Fig. 2 shows a cross-section of a flume constructed by the Mines Timber Co., in the Deer Lodge National Forest, in Montana. In this figure, *c* represents clearance of the log from the side of the flume; *b* represents the length of the side, and *d* represents the depth of the water to the top of the triangular stop. These terms as so defined are used in general in the succeeding plates and diagrams. This particular flume is 16 miles long and has grades varying from 0.5 to 12.5% and is supplied with water at several places throughout its length. The flows of water vary from 7 to 22 sec. ft. The flume is built of 16-ft. boxes joined together; each


Depth of Water in Flume in Inches. (1"Clearance between Log and Sides of Flume and Δ Ship 3" High in Vertex, see Fig. 1)
5 lb. per B.M. Ft.
4 lb.
3 lb.
2 lb.
FIG. 3
ENG. NEWS
Diameter of Log in Inches

Example for Fig. 3. Given a log with a large diameter of 24 in., a weight of 4 lb. per ft. b.m., it is required to find the depth of water to float it. Follow the ordinate for 24 in. to the inclined line representing 4 lb., then follow the corresponding abscissa to the axis which shows 20.5 in.

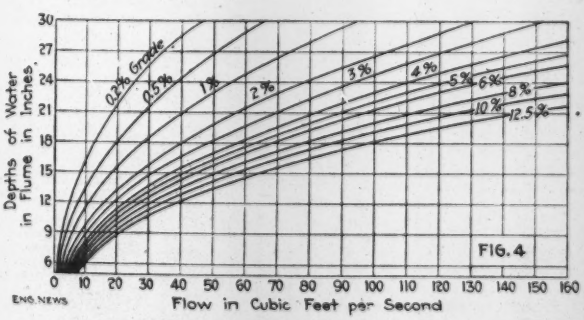
box has three supports, 5 ft. 4 in. center to center. Where the bottom of the flume is less than about 4 ft. above ground, each support has its own bent; where the flume is higher, bents are placed only at the ends of the boxes, the intermediate supports being carried by stringers.

Fig. 3 shows the relations between diameters of logs, weight of logs per board foot and depth of water in the flumes; having given the diameter and weight per board foot, the depth of water required in the flume to float the log can be determined. Examples of the use of this and the following diagrams are given below the proper figure.

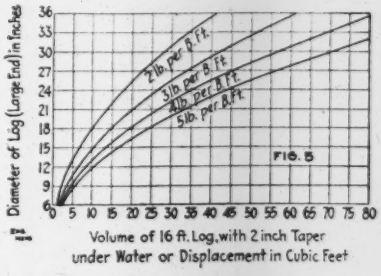
Fig. 3 was prepared using a side clearance of 1 in. between the log and the flume. For each additional inch in clearance desired the required depth of water is 1.5 in. additional (1.41 actual).

Fig. 4 shows the relations between the depth of water in the flume, grades and flows in cubic feet per second.* Having given the depth of water in the flume and the grade, the flow can be determined from this diagram or *vice versa*. In forming this diagram Kutter's formula was used with a coefficient of roughness *n* of 0.012. The velocities obtained were checked by measuring the velocities of the water in the flume of the Mines Timber Co. on the Deer Lodge National

*The abbreviations "sec. ft.," "acre ft.," are used in what follows as abbreviations, respectively, for cubic feet per second and cubic feet per acre under one foot depth.




Example for Fig. 4. Given a depth of water of 22 in. in the 5% grade to find the corresponding flow. Follow the abscissa for 22 in. to the curve for 5%. Then follow down the corresponding ordinate which shows 100 cu.ft. per sec.

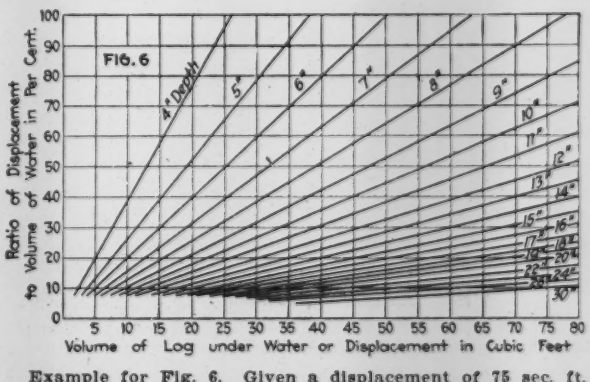

Diameter of Log (Large End) in Inches
2 lb. per B.M. Ft.
3 lb. per B.M. Ft.
4 lb. per B.M. Ft.
5 lb. per B.M. Ft.
FIG. 5
Volume of 16 ft. Log, with 2 inch Taper
under Water or Displacement in Cubic Feet

Example for Fig. 5. Given a 23-in. log weighing 5 lb. per ft. b.m. to find its displacement. Follow the abscissa for 23 in. to the curve representing 5 lb., and trace down the corresponding ordinate to find 40 cu.ft. These curves are for 16-ft. logs. If the logs were 30 ft. long the displacement would be $\frac{30}{16} \times 40 = 75$ cu.ft. This is not exact, but is sufficiently accurate.

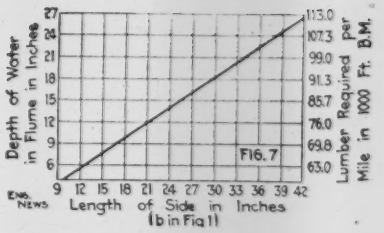
Forest, using a current meter on lighter grades and by timing floating logs on the heavier grades. It should be noted, however, that logs travel faster than the water in which they float. These extra velocities of logs are discussed later. A 6-in. triangular piece in the vertex of the flume is assumed as shown in Fig. 2. The area of cross-section of the flume is corrected for this strip, etc.

Fig. 5 shows relations between diameters of logs, weight per board foot, and displacement of 16-ft. logs with a 2-in. taper; having given the large diameter of the log and weight per board foot, the volume under water or displacement can be determined. If the log in question is of any other length than 16 ft., the volume would be approximately in proportion; this is not exact, but is accurate enough for all practical purposes.

Fig. 6 shows relations between volume of a log under water, or displacement, depth of water and ratio of displacement to total volume of water in a 100-ft. length of flume. If there should be one log in every 50 ft. of flume instead of 100 ft., the percentage of displacement would be twice as great, etc. Since the logs travel faster than the water, thereby increasing the discharges, an increase




Example for Fig. 6. Given a displacement of 75 sec. ft. for the 30-ft. log and the corresponding depths as shown in Fig. 5, find the desired ratio of displacement to total volume of water in 100-ft. lengths of flume. Follow the ordinate for 75 cu.ft. to the line representing 22 in. depth. The abscissa for this point shows 17% on the scale axis. The diagram is prepared for 100-ft. length of flume; if there should be one log in every 50 ft., the percentage would be twice as great.




Example for Fig. 7. Given a depth of 14 in., find the length of side and amount of lumber per mile required for a flume. Follow the abscissa for 14 in. to the line of the diagram; the corresponding ordinate shows 24 in. The diagram shows that the abscissa, corresponding to the 14-in. depth, also indicates 83. M. ft. b.m. per mile.

which cannot be computed, however, and since there is a loss of water through leakage which cannot be computed, it is safer not to use the displacement to reduce the discharge found from Fig. 4, except where the flume is to be nearly full of logs and where there will be only light grades. Height is given to the top of the 3-in. triangular stop and the area is corrected for the volume of this strip.

Fig. 7 shows the relations between depth of water in the flume, length of side and amount of lumber used in the construction. In computing the amount of lumber, 4 in. has been added to the length of each side to make allowance for height above the water surface and for lapping at the vertex. The figures for lumber do not allow for waste and include only the material shown in Fig. 2. Material for bents and stringers is extra.

Fig. 8 shows relations between crooks of the logs of certain lengths with certain clearances and the allowable curvature of the flume, both horizontal and vertical. The diagram takes into account the greater clearance in a horizontal direction from that given in Fig. 1 by the symbol *c* and it is assumed that the crook will lie horizontally. The crook is taken against the curvature of the flume in each case. It is seen from this figure that with a straight log with 1-in. radial clearance, the allowable curvature is 57°,

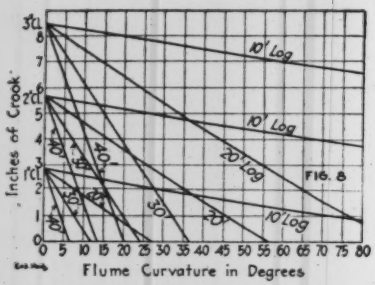


FIG. 8

Example for Fig. 8. Given a 20-ft. log with a crook of 4 in. and a 2-in. clearance to find the allowable curvature of flume. Use the lines designated for 2-in. clearance and the abscissa for 4-in. crook; the ordinate of the intersection shows an allowable curvature for horizontal and vertical of 16°. As the curvature there is nearly proportional to the square of the length of the log, interpolation can be made for lengths between those given. If the above log were 25 ft. long, the curvature would be $\left(\frac{20}{25}\right)^2 \times 16° = 10°$.

nearly. It is also seen from a study of the left side of the diagram that logs with 3-, 6- and 9-in. crooks would scrape the sides of the flumes if only 1-, 2- and 3-in. clearances were allowed, respectively. The clearances are values in respect to straight logs. Curvature in degrees varies almost inversely as the square of the length of the log, so that interpolation can be made for length between those given.

Fig. 9 shows relation between diameter of logs, weight per board foot, and total weights. The diameters are of the large end. Weights are for 20-ft. logs having a taper of 2 in. From the total weight, the part acting parallel to the flume or the "flume component," so called, can be determined if the grade is known, by multiplying weight by grade in per cent. In this method of computing flume component, the total weight is taken as acting perpendicular to the flume, which is not the case, but as the difference is slight the simple method is sufficiently accurate and is preferred. With this assumption the flume component is the total weight times the *sine* of the angle the flume makes with the horizontal, the latter factor being numerically equal to the grade in per cent.

Fig. 10 shows the relations between the diameter of logs, weight per board

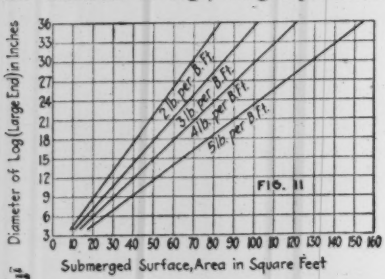
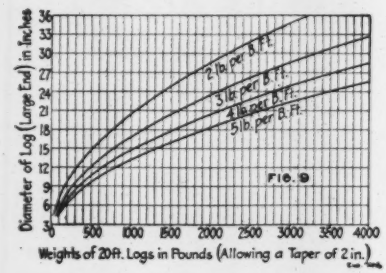


FIG. 11

Example for Fig. 11. Given a 20-ft. log, 22 in. in diameter and a weight of 4 lb. per board foot; to find the submerged surface area. Follow the abscissa of 22 in., to the intersection with the curve for 4 lb. Find then the corresponding ordinate which is that of 74 sq.ft.


Diameter of Log (Large End) in Inches
2 lb. per B.Ft.
3 lb. per B.Ft.
4 lb. per B.Ft.
5 lb. per B.Ft.
Weights of 20 Ft. Logs in Pounds (Allowing a Taper of 2 in.)
FIG. 9

Example for Fig. 9. Given a 20-ft. log with a large diameter of 22 in., a weight of 4 lb. per ft. b.m., and a flume grade of 5%, find the total weight and the flume component. The ordinate of the intersection of the curve for 4 lb. and the 22-in. abscissa, shows 2320 lb. The flume component for all practical purposes is weight times grade in per cent., or $2320 \times 0.05 = 116$ lb. If the log were 30 ft. long instead of 20, the total weight can be taken as $\frac{30}{20} \times 2320$, or 3480 lb.

foot, and end area of logs submerged. This figure is to be used with Figs. 9 and 11 in computing the velocity of the logs in respect to the velocity of the water.

A log floating in an inclined flume or other channel tends to accelerate in velocity and to reach a velocity greater than that of the surrounding water. The force exerted to produce this relative velocity is the resolved component of the weight of the log acting parallel to the flume. Opposed to this force is the pressure of the water against the lower end of the log and the friction of the water on its sides. Both of these opposing forces vary directly as the area of contact and as the square of the relative velocity.

Expressed in mathematical terms,

$$\text{End pressure} = K_1AV^2$$

$$\text{Side friction} = K_2AV^2$$

These are opposed to the flume component and their sum is very slightly less. It is approximately correct, however, to write

$$W = K_1AV^2 + K_2SV^2$$

$$V = \sqrt{\frac{W}{K_1A + K_2S}}$$

No experiments have been made by the writer to determine the limits of $K_1$ and $K_2$. In fact, such studies would seem impracticable and unnecessary for the present purposes. The values are $K_1 = 1$ and $K_2 = 0.004$ for logs without bark, or $K_2 = 0.01$ for logs with bark. Excess

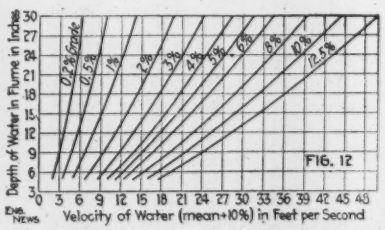


FIG. 12

Example for Fig. 12. Given a depth of water of 25.5 in. corresponding to a 22-in. log of 4-lb. weight per board foot and a grade of 5%, find the velocity of the water. Find the abscissa representing 25.5 in. and its intersection with the line for 5% grade; the corresponding ordinate is seen to be for 28.5 ft. per sec.

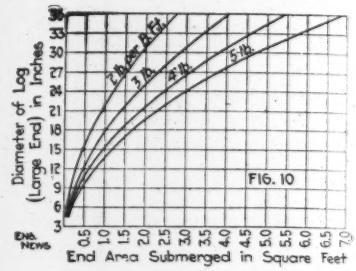


FIG. 10

Example for Fig. 10. Given a log 22 in. diameter and a weight of 4 lb. per ft. b.m., to find the submerged area of the end of the log. Follow the abscissa of 22 in. to the intersection with the curve for 4 lb.; the corresponding ordinate represents an end area of 2.04 sq.ft.

velocity is to be computed from Fig. 11, which shows relations between log diameter, weight per board foot, and submerged surface area, using a 20-ft. log. Fig. 11 is corrected for 2-in. taper in 20-ft. logs of 2 ft. diameter.

Fig. 12 shows relations between depth of water in the flume, grades, and velocity of water in feet per second. In preparing this figure the velocities of water used in computing discharges in Fig. 4 were increased 10% to give approximately the velocity at the center where the log would travel. This increase probably would also compensate for the extra velocity given the water by the super-velocity of the logs.

The capacity of a flume in number of logs per hour may be computed by dividing the distance of logs center to center by the velocity they have in feet per hour. As a matter of convenience, these computations have been plotted in Fig. 13, showing velocities in feet per second and capacity for one log in 100 ft. length of flume, or 100 ft. center to center.

### Use of Diagrams

To show the use of the diagrams developed, it is necessary to assume certain information as in hand and follow its development. First, it is to be assumed that a lumberman has made an examina-

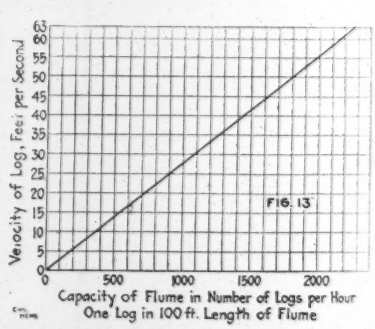


FIG. 13

Example for Fig. 13. Suppose an excess velocity of a peeled log of 7 ft. per sec. with respect to the water, a water velocity of 28.4 ft. per sec. and a total log velocity of 35.4 ft. per sec., find the capacity of the flume. Find the abscissa for 35.4 ft. per sec. and its intersection with the diagonal of the diagram. The corresponding ordinate is found to show 1270 logs per hour for one log in each 100 ft. of flume (or logs 100 ft. center to center). If there should be one log in every 200 ft. of flume, the capacity would be 635.

tion of the timbered area from which it is desired to flume the cut to the mill; he should have secured the following data in the field—(1) amount of timber, (2) number of logs of various diameters and lengths, (3) weight of logs per board foot when flumed, (4) limit of allowable crook in a log, (5) number and location of streams available for use, (6) available flow in each throughout the year, (7) the length of the flume, (8) the grades and lengths of each flume, (9) the storage possibilities of each stream. Suppose that the values from the timber survey are as follows: (1) 100,000,000 M. ft. b.m.; (2) two streams in the timber tract, one at the head of the flume and the other about half way between the head and the mill; (3) the flows in each varying between 6 and 78 sec. ft., according to the hydrograph shown in Fig. 14; (4) a length of necessary flume of 14 miles, and grades, beginning at the head, as five miles of 1%, one mile of 5%, eight miles of 2%; (5) a reservoir of 5 acre-ft. capacity formed in the stream at the head of the flume, but none in the feeder It is assumed also that, on the 1% grade, four logs will travel in every 100 ft. of flume, that is, 25 ft. center to center.

From Fig. 8 it is seen that for a crook of 3 in., 1 in. clearance is not sufficient but a 2-in. is. From Figs. 3 and 4 the following depths of water in the flume and flows on a 5% grade are found necessary to float the various diameters of logs. It should be noted that for a 2-in. clearance needed 1½ in. has to be added to the values of depth found directly from Fig. 3.

| Large Diam. Inches | Inches Depth | Flow Sec. Ft. |
|---|---|---|
| 32 | 24.5 | 130 |
| 26 | 20.0 | 80 |
| 23 | 17.5 | 60 |
| 22 | 17.0 | 55 |
| 20 | 15.0 | 41 |
| 18 | 13.5 | 32 |
| 16 | 12.0 | 25 |
| 12 | 9.0 | 13 |

From Fig. 5 the displacement of the various groups of logs are found, assuming that they are to be flumed in groups according to diameters. See Table I.

TABLE I.

| Group | Large Diam., in. | Lengths, ft. | Displacement cu.ft. | Comparative weights of groups* | Av. displacement cu.ft. |
|---|---|---|---|---|---|
| 1 | 32 | 12 | 36 | 45 | 36 |
| | | 14 | 43 | 45 | |
| | | 16 | 49 | 45 | |
| | 26 | 12 | 23 | 45 | |
| | | 14 | 27 | 45 | |
| | | 16 | 31 | 45 | |
| | | 18 | 35 | 45 | |
| | | 20 | 39 | 30 | |
| | | 22 | 43 | 1 | |
| | | 24 | 46 | 1 | |
| | 23 | 18 | 27 | 18 | |
| | 22 | 12 | 17 | 18 | |
| | | 14 | 19 | 18 | |
| | | 16 | 22 | 18 | |
| 2 | 20 | 12 | 14 | 18 | 19 |
| | | 14 | 16 | 18 | |
| | | 16 | 18 | 18 | |
| | | 18 | 20 | 18 | |
| | | 20 | 22 | 12 | |
| | 18 | 22 | 20 | 1 | |
| | | 24 | 23 | 1 | |
| 3 | 16 | 18 | 13 | 18 | 13 |
| | | 20 | 14 | 15 | |
| | | 22 | 9 | 1 | |
| | | 24 | 10 | 1 | |

*The comparative weights are the ratio between the number of logs of each dimension.

TABLE II.

| Group | Grades per cent. | Depths in. | Velocities, ft. per sec. | Distances C.toC. ft | Displacement cu.ft. | Ratio displacement. per cent. |
|---|---|---|---|---|---|---|
| 1 | 1 | 24.5 | 12.4 | 25 | 36 | 26 |
| | 5 | 24.5 | 27.5 | 55 | 36 | 12 |
| | 2 | 24.5 | 17.4 | 35 | 36 | 19 |
| 2 | 1 | 17.5 | 10.0 | 25 | 19 | 24 |
| | 5 | 17.5 | 22.4 | 56 | 19 | 11 |
| | 2 | 17.5 | 14.2 | 36 | 19 | 17 |
| 3 | 1 | 12.0 | 8.0 | 25 | 13 | 34 |
| | 5 | 12.0 | 18.0 | 56 | 13 | 15 |
| | 2 | 12.0 | 11.3 | 35 | 13 | 25 |

From Fig. 12 the approximate comparative velocities of the logs and the distances center to center on the 1%, 5% and 2% grades may be found as given in Table II, using the depth required to float the largest log of each group. From Fig. 6 the ratio of displacement to total volume of water is found for 100 ft. center to center and increased in proportion to the distances apart shown. Since the possible reduction of volume amounts to only 12% on the 5% grade for Groups 1 and 2, it would not be advisable to reduce the flow correspondingly. It would be better to allow this excess to compensate for leakage and the increased velocities of the water due to the extra velocities acquired by the logs.

From Fig. 9 the total weights of the logs and the flume components of the weight may be computed, while from Fig. 11 are found the submerged surface areas of the logs of each group. These are shown in Table III.

From Fig. 10 the submerged end areas are found for the logs as given in Table IV.

By trial, using the formula before given for movement of (peeled) logs, it is seen that the velocity increases with the diameter and with the length. It is evident that, in fluming logs of various diameters and lengths at the same time, the larger logs will overtake the smaller ones and the group will travel at a speed corresponding to the largest diameter and the combined length. From previous figures on displacement of logs, it is seen that some of the different sizes in each group are comparatively few in number. For convenience these few will be neglected and traveling bunches considered to consist of one log of each length in the different groups except the ones that are few in number. The values for submerged surface area, flume components, extra velocities, etc., according to the formulas already given, are arranged in Table V.

From Fig. 12 the velocities of the water and the total velocities of the logs may be found and these have been tabulated.

| Group | Depths inches | Grade per cent. | Water velocity feet per sec. | Log velocity feet per second | Total velocity feet per second |
|---|---|---|---|---|---|
| 1 | 24.5 | 1 | 12.4 | 5.8 | 18.2 |
| | | 5 | 27.5 | 13.1 | 40.6 |
| | | 2 | 17.4 | 8.3 | 25.7 |
| 2 | 17.5 | 1 | 10.0 | 5.7 | 15.7 |
| | | 5 | 22.4 | 12.9 | 35.3 |
| | | 2 | 14.2 | 8.1 | 22.3 |
| 3 | 12.0 | 1 | 8.0 | 3.8 | 11.8 |
| | | 5 | 18.0 | 8.6 | 26.6 |
| | | 2 | 11.3 | 5.4 | 16.7 |

TABLE III.

| Group | Large diam. in. | Submerged surface area sq. ft. | Length, ft. | Total weight, lb. | Grades per cent. | Flume components lb. |
|---|---|---|---|---|---|---|
| 1 | 32 | 54 | 12 | 2,250 | 1 | 22.5 |
| | | | | | 5 | 112.5 |
| | | | | | 2 | 45.0 |
| | | 63 | 14 | 2,625 | 1 | 26.3 |
| | | | | | 5 | 131.3 |
| | | | | | 2 | 52.5 |
| | | 72 | 16 | 3,000 | 1 | 30 |
| | | | | | 5 | 150 |
| | | | | | 2 | 60 |
| | 26 | 44 | 12 | 1,485 | 1 | 14.8 |
| | | | | | 5 | 73.8 |
| | | | | | 2 | 29.6 |
| | | 51 | 14 | 1,730 | 1 | 17.3 |
| | | | | | 5 | 86.1 |
| | | | | | 2 | 34.6 |
| | | 58 | 16 | 1,975 | 1 | 19.7 |
| | | | | | 5 | 98.4 |
| | | | | | 2 | 39.5 |
| | | 66 | 18 | 2,225 | 1 | 22.2 |
| | | | | | 5 | 112.5 |
| | | | | | 2 | 44.4 |
| | | 73 | 20 | 2,470 | 1 | 24.7 |
| | | | | | 5 | 123.5 |
| | | | | | 2 | 49.4 |
| | | 80 | 22 | 2,706 | 1 | 27.1 |
| | | | | | 5 | 135.3 |
| | | | | | 2 | 54.1 |
| | | 88 | 24 | 2,952 | 1 | 29.5 |
| | | | | | 5 | 147.6 |
| | | | | | 2 | 59.0 |
| | 23 | 59 | 18 | 1,728 | 1 | 17.3 |
| | | | | | 5 | 86.4 |
| | | | | | 2 | 34.6 |
| | | 37 | 12 | 1,050 | 1 | 10.5 |
| | | | | | 5 | 52.5 |
| | | | | | 2 | 21.0 |
| | 22 | 50 | 16 | 1,400 | 1 | 14.0 |
| | | | | | 5 | 70.0 |
| | | | | | 2 | 28.0 |
| | | 43 | 14 | 1,225 | 1 | 12.3 |
| | | | | | 5 | 61.3 |
| | | | | | 2 | 24.5 |
| | | 34 | 12 | 854 | 1 | 8.5 |
| | | | | | 5 | 42.7 |
| | | | | | 2 | 17.0 |
| 2 | | 40 | 14 | 996 | 1 | 10.0 |
| | | | | | 5 | 49.8 |
| | | | | | 2 | 19.9 |
| | 20 | 45 | 16 | 1,139 | 1 | 11.4 |
| | | | | | 5 | 57.0 |
| | | | | | 2 | 22.8 |
| | | 51 | 18 | 1,282 | 1 | 12.8 |
| | | | | | 5 | 64.1 |
| | | | | | 2 | 25.6 |
| | | 56 | 20 | 1,425 | 1 | 14.3 |
| | | | | | 5 | 71.2 |
| | | | | | 2 | 28.5 |
| | | 56 | 22 | 1,254 | 1 | 12.5 |
| | 18 | | | | 5 | 62.7 |
| | | | | | 2 | 25.1 |
| | | 61 | 24 | 1,368 | 1 | 13.7 |
| | | | | | 5 | 68.4 |
| | | | | | 2 | 27.4 |
| | | 40 | 18 | 800 | 1 | 8.0 |
| | 16 | | | | 5 | 40.0 |
| | | | | | 2 | 16.0 |
| | | 45 | 20 | 890 | 1 | 8.9 |
| 3 | | | | | 5 | 44.5 |
| | | | | | 2 | 17.8 |
| | | 37 | 22 | 540 | 1 | 5.4 |
| | 12 | | | | 5 | 27.0 |
| | | | | | 2 | 10.8 |
| | | 41 | 24 | 588 | 1 | 5.9 |
| | | | | | 5 | 29.4 |
| | | | | | 2 | 11.8 |

TABLE IV.

| Group | Diameter inches | Submerged end areas square feet |
|---|---|---|
| 1 | 32 | 3.2 |
| | 26 | 2.1 |
| | 23 | 1.66 |
| 2 | 22 | 1.5 |
| | 20 | 1.25 |
| | 18 | 1.0 |
| 3 | 16 | 0.8 |
| | 12 | 0.46 |

TABLE V.

| Group | A sq.ft. | S sq.ft. | Grade per cent. | W lb. | V ft. per sec. |
|---|---|---|---|---|---|
| 1 | 3.2 | 481 | 1 | 177.2 | 5.8 |
| | | | 5 | 885.8 | 13.1 |
| | | | 2 | 354.3 | 8.3 |
| 2 | 1.66 | 415 | 1 | 111.1 | 5.7 |
| | | | 5 | 555.0 | 12.9 |
| | | | 2 | 221.9 | 8.1 |
| 3 | 0.8 | 85 | 1 | 16.9 | 3.8 |
| | | | 5 | 84.5 | 8.6 |
| | | | 2 | 33.8 | 5.4 |

The deciding grade for the capacity of the flume is the 1% since the logs are to be placed in that portion 25 ft. center

to center. From Fig. 13 it is found that the capacity and number of hours required for fluming are as follows:

| Group | Velocity of logs | Capacity number per hour | Total number of logs | Hours |
|---|---|---|---|---|
| 1 | 18.2 | 2,640 | 1,388,000 | 526 |
| 2 | 15.7 | 2,240 | 1,580,000 | 705 |
| 3 | 11.8 | 1,720 | 350,000 | 204 |

The solution of the problem is now at hand, but it is necessary to cover, first, Group 1, then Group 2, and finally Group 3. From Fig. 4 the flows necessary to float Group 1 are found to be thus:

| Grade | Diameter largest log | Depth | Flows sec. ft. |
|---|---|---|---|
| 1 | 32 | 24.5 | 58 |
| 5 | 32 | 24.5 | 130 |
| 2 | 32 | 24.5 | 82 |

The data secured show that there are two streams available, each having a hydrograph as given by Fig. 14, one assumed as diverted into the head of the flume and the other into the upper end of the 5% grade. Let it be considered that it is impracticable to flume in less than one-hour periods. For arriving at a first approximation of the period for fluming, assume that the fluming can be carried on during five hours of each day during the period selected. There would, therefore, be approximately 105 days, since it would take 526 hours to flume the group; 105 days, counting out Sundays, would make approximately four months. By reference to Fig. 14, it is seen that the four months' period having the greatest flow lies between Apr. 9 and Aug. 8.

In Table VI the days and corresponding flows in each stream have been tabulated from Fig. 14. The amount needed from storage each day is computed by deducting from 130 sec. ft. (the maximum flow required to float the largest logs over the limiting section of 5% grade), twice the natural flow of each stream. The time required to fill the reservoir is found by dividing 5 acre-ft. (reduced to cu.ft.) by the natural flow in one stream. The time to drain the reservoir is found by dividing 5 acre-ft. (reduced to cu.ft.) by the amount drawn from storage. For example, on Apr. 9 the natural flow in each stream is 15 sec. ft. The amount needed from storage is $130 - (2 \times 15)$, or 100 sec. ft. The time required to fill the reservoir is $\frac{5 \times 43{,}560}{15 \times 3{,}600}$ or 4 hr. The time in which the reservoir will drain is $\frac{5 \times 43{,}560}{100 \times 3{,}600}$ or 0.6 hr. In the last column of Table VI are given the number of hours fluming can occur during each day, an explanation of which will be given later; each seventh day being Sunday is omitted. Plotting a curve with hours as abscissas and flows as ordinates for several hours and corresponding flows is a quick method of ascertaining the hours required to fill and drain the reservoir for intermediate flows.

In fluming it is considered best to allow 30 min. extra time in each fluming period to insure that sufficient water shall be in the flume to float the logs. Since it is considered impracticable to flume for shorter periods than one hour, the above table shows that fluming of Group 1 logs can only occur between May 21 and June 26. Outside of this interval the flow from storage would drain the reservoir in less than 1 hr. 30 min. with 1 hr. allowed for fluming and 30 min. for extra flow. By adding the time for draining and for filling the reservoir, and deducting this from 11 hr. successively the number of fluming periods and the duration per day is found, as for example, on May 21 the sum is $1.2 + 1.9 = 3.1$ $11 - 3.1 = 7.9$ $7.9 - 3.1 = 4.8$ $4.8 - 3.1 = 1.7$. There are three cycles and hence four fluming periods. The water flows for three periods of 1.9 hr. each and one of 1.7 hr; logs are flumed three periods of 1.9 — 0.5, or 1.4 hr. each, and one of 1.7 — 0.5 or 1.2 hr., making a total for the day of 5.4 hr. The mid-day rest is to be taken when the reservoir is filling.

The total number of hours during which fluming can occur between May 21 and June 26 is seen to be 240.8 hr. Since it would take 526 hr. to flume Group 1, it is evident that it would take three years to flume the entire group. Suppose the time is divided equally between the three years; there would, therefore, be 175 hr. required each year. By trial, using the last column in the above table, 175 hr. could conveniently occur between May 26 and June 19 inclusive.

During this period 130 sec. ft. are flowing in the 5 and 2% grades, of which 49 sec. ft. is the least diverted from the feeder. The most needed from the head of the flume is 81 sec. ft., and the least 65 sec. ft. This 65 sec. ft. is sufficient for floating the logs on the initial 1% grade as only 58 sec. ft. is required. Since only 82 sec. ft. is required to float the logs of Group 1 along the 2% grade, it might be well to waste some of the excess water at the beginning of that grade in order to reduce the height of the sides and the amount of lumber required over that for a flume which would carry 130 sec. ft.

It has been previously shown that the 1, 5 and 2% grades the ratio displacement of the logs is 26, 12 and 19%, respectively. Since no reduction is made on account of the displacement, the total volume of the flume below the surface of the water should be considered as the needed volume of the water plus the volume of displacement, in obtaining the length of the sides necessary. The volume in terms of flow, the depth, lengths

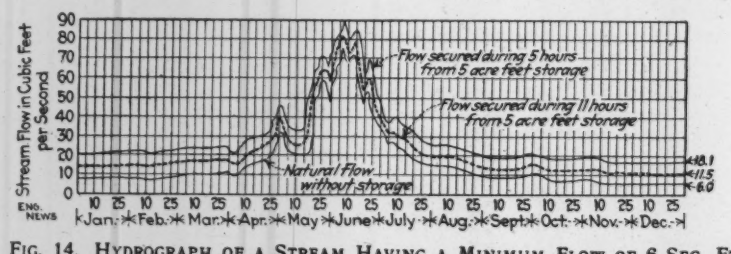

Stream Flow in Cubic Feet per Second
Flow secured during 5 hours from 5 acre feet storage
Flow secured during 11 hours from 5 acre feet storage
Natural Flow without storage
18.1
11.5
6.0
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
ENG. NEWS

FIG. 14. HYDROGRAPH OF A STREAM HAVING A MINIMUM FLOW OF 6 SEC. FT.

TABLE VI.

| Date | Nat. flows each stream second feet | Period days | Storage flow sec. ft. | Filling reservoir hours | Drain-reservoir hours | Fluming period Number | Fluming period Total hours |
|---|---|---|---|---|---|---|---|
| Apr. 9 | 15 | 1 | 100 | 4.0 | 0.6 | | |
| Apr. 10 | 16 | 1 | 98 | 3.7 | 0.6 | | |
| Apr. 11 | 17 | | | | | | |
| Apr. 12 | 17 | | | | | | |
| Apr. 13 | 17 | | | | | | |
| Apr. 14 | 17 | 7 | 96 | 3.6 | 0.6 | | |
| Apr. 16 | 17 | | | | | | |
| Apr. 17 | 17 | | | | | | |
| Apr. 18 | 17 | | | | | | |
| Apr. 19 | 18 | | | | | | |
| Apr. 20 | 18 | | | | | | |
| Apr. 21 | 18 | 5 | 94 | 3.4 | 0.6 | | |
| Apr. 23 | 18 | | | | | | |
| Apr. 24 | 18 | | | | | | |
| Apr. 25 | 19 | 1 | 92 | 3.2 | 0.7 | | |
| Apr. 26 | 20 | 1 | 90 | 3.0 | 0.7 | | |
| Apr. 27 | 22 | 1 | 86 | 2.8 | 0.7 | | |
| Apr. 28 | 26 | 1 | 78 | 2.3 | 0.8 | | |
| Apr. 30 | 30 | 1 | 70 | 2.0 | 0.9 | | |
| May 1 | 34 | 1 | 62 | 1.8 | 1.0 | | |
| May 2 | 32 | 1 | 66 | 1.9 | 0.9 | | |
| May 3 | 29 | 1 | 72 | 2.1 | 0.8 | | |
| May 4 | 26 | 1 | 78 | 2.3 | 0.8 | | |
| May 5 | 23 | 1 | 24 | 2.6 | 0.7 | | |
| May 7 | 22 | | | | | | |
| May 8 | 22 | 2 | 86 | 2.8 | 0.7 | | |
| May 9 | 21 | | | | | | |
| May 10 | 21 | | | | | | |
| May 11 | 21 | | | | | | |
| May 12 | 21 | 6 | 88 | 2.9 | 0.7 | | |
| May 14 | 21 | | | | | | |
| May 15 | 21 | | | | | | |
| May 16 | 22 | 1 | 86 | 2.8 | 0.7 | | |
| May 17 | 29 | 1 | 72 | 2.1 | 0.8 | | |
| May 18 | 35 | 1 | 60 | 1.7 | 1.0 | 4 | |
| May 19 | 40 | 1 | 50 | 1.5 | 1.2 | 4 | |
| May 21 | 49 | 1 | 32 | 1.2 | 1.9 | 4 | |
| May 22 | 51 | | | | | | |
| May 23 | 51 | 2 | 28 | 1.2 | 2.2 | 6 | 10.2 |
| May 24 | 52 | 1 | 26 | 1.2 | 2.3 | 3 | 5.4 |
| May 25 | 58 | 1 | 14 | 1.0 | 4.3 | 2 | 7.6 |
| May 26 | 59 | | | | | | |
| May 28 | 59 | 2 | 12 | 1.0 | 5.0 | 4 | 18.0 |
| May 29 | 54 | 1 | 22 | 1.1 | 2.8 | 3 | 6.0 |
| May 30 | 49 | 1 | 32 | 1.2 | 1.9 | 4 | 6.4 |
| May 31 | 60 | 1 | 10 | 1.0 | 6.0 | 2 | 9.0 |
| June 1 | 62 | 1 | 6 | 1.0 | 11.0 | 2 | 9.0 |
| June 2 | 65 | 1 | 0 | 0.9 | 11.0 | 2 | 9.0 |
| June 4 | 70 | | | | | | |
| June 5 | 70 | 2 | 0 | 0.9 | 11.0 | 4 | 18.0 |
| June 6 | 71 | 1 | 0 | 0.9 | 11.0 | 2 | 9.0 |
| June 7 | 78 | 1 | 0 | 0.8 | 11.0 | 2 | 9.0 |
| June 8 | 72 | 1 | 0 | 0.8 | 11.0 | 2 | 9.0 |
| June 9 | 68 | | | | | | |
| June 11 | 68 | 2 | 0 | 0.9 | 11.0 | 4 | 18.0 |
| June 12 | 70 | 1 | 0 | 0.9 | 11.0 | 2 | 9.0 |
| June 13 | 72 | 1 | 0 | 0.8 | 11.0 | 2 | 9.0 |
| June 14 | 74 | | | | | | |
| June 15 | 74 | 2 | 0 | 0.8 | 11.0 | 4 | 18.0 |
| June 16 | 70 | 1 | 0 | 0.9 | 11.0 | 2 | 9.0 |
| June 18 | 58 | 1 | 14 | 1.0 | 4.3 | 2 | 7.6 |
| June 19 | 51 | 1 | 28 | 1.2 | 2.2 | 3 | 5.1 |
| June 20 | 45 | 1 | 40 | 1.4 | 1.0 | 4 | 4.0 |
| June 21 | 40 | 1 | 32 | 1.3 | 1.9 | 4 | 6.2 |
| June 22 | 54 | 1 | 22 | 1.1 | 2.8 | 3 | 6.9 |
| June 23 | 56 | 1 | 18 | 1.1 | 3.4 | 3 | 7.3 |
| June 25 | 47 | 1 | 36 | 1.3 | 1.9 | 4 | 4.8 |
| June 26 | 44 | 1 | 42 | 1.4 | 1.5 | 4 | 4.0 |
| June 27 | 41 | 1 | 48 | 1.5 | 1.3 | | |
| June 28 | 40 | 1 | 50 | 1.5 | 1.2 | | |
| June 29 | 38 | 1 | 54 | 1.6 | 1.1 | | |
| June 30 | 37 | 1 | 56 | 1.6 | 1.1 | | |
| July 2 | 32 | 1 | 66 | 1.9 | 0.9 | | |
| July 3 | 31 | 1 | 68 | 1.9 | 0.9 | | |
| July 4 | 29 | 1 | 72 | 2.1 | 0.8 | | |
| July 5 | 27 | | | | | | |
| July 6 | 27 | 3 | 76 | 2.2 | 0.8 | | |
| July 7 | 27 | | | | | | |
| July 9 | 26 | 1 | 78 | 2.3 | 0.8 | | |
| July 10 | 25 | | | | | | |
| July 11 | 25 | | | | | | |
| July 12 | 25 | 4 | 80 | 2.4 | 0.8 | | |
| July 13 | 25 | | | | | | |
| July 14 | 24 | 1 | 82 | 2.5 | 0.7 | | |
| July 16 | 23 | 1 | 84 | 2.6 | 0.7 | | |
| July 17 | 22 | | | | | | |
| July 18 | 22 | 2 | 86 | 2.8 | 0.7 | | |
| July 19 | 21 | 1 | 88 | 2.9 | 0.8 | | |
| July 20 | 20 | | | | | | |
| July 21 | 20 | 2 | 90 | 3.0 | 0.7 | | |
| July 23 | 18 | 1 | 94 | 3.4 | 0.6 | | |
| July 24 | 17 | | | | | | |
| July 25 | 17 | 3 | 96 | 3.5 | 0.6 | | |
| July 26 | 17 | | | | | | |
| July 27 | 16 | 1 | 98 | 3.8 | 0.6 | | |
| July 28 | 15 | | | | | | |
| July 30 | 15 | | | | | | |
| July 31 | 15 | 5 | 100 | 4.0 | 0.6 | | |
| Aug. 1 | 15 | | | | | | |
| Aug. 2 | 15 | | | | | | |
| Aug. 3 | 16 | | | | | | |
| Aug. 4 | 16 | 2 | 98 | 3.8 | 0.6 | | |
| Aug. 6 | 15 | 1 | 100 | 4.0 | 0.6 | | |
| Aug. 7 | 14 | | | | | | |
| Aug. 8 | 14 | 2 | 102 | 4.3 | 0.6 | | |

of sides and amount of lumber for the flume are then shown by Table VII.

In this table the depths are secured from Fig. 4, the length of sides and lumber per mile from Fig. 7, and total amount of lumber from the number of miles from each grade given in the data obtained by the timber survey. Lumber does not include material in the bents for supporting the flume.

Next it is necessary to take up Group 2. Since it takes three years to flume Group 1, Groups 2 and 3 should be divided equally between three years. As has been shown, Group 2 requires 705 hr. fluming, or 235 hr. each year. Also, as has been shown, the depth required is 17.5 in. with flows as follows:

| Grade per cent. | Diameter largest log inches | Depth inches | Flows sec. ft. |
|---|---|---|---|
| 1 | 23.0 | 17.5 | 26.5 |
| 5 | 23.0 | 17.5 | 59.0 |
| 2 | 23.0 | 17.5 | 37.5 |

Now a table of flows, storage, etc., needs to be prepared similar to the one shown for Group 1. Such a table is appended for between Apr. 11 and May 25, and between June 20 and July 19 inclusive (Table VIII).

These two periods give a total of 477.6 hr., which is more than sufficient, since only 235 hr. are required in one year. By reference to the table, it is found that 235 hr. will occur between May 9 and May 25, and June 20 and July 5, inclusive. During this period there will be flowing in the 5 and 2% grades 59 sec. ft., and from reference to the table the least amount needed from the head will be 30 sec. ft. (on May 17 and July 4) which is more than sufficient to float the logs, since 26.5 sec. ft. are required for that grade.

For Group 3, it has been shown that 204 hr. fluming is required, or 68 hr. in each of three years. The depths and flows are as follows:

| Grade per cent. | Diameter largest log inches | Depths inches | Flows |
|---|---|---|---|
| 1 | 16 | 12 | 11.0 |
| 5 | 16 | 12 | 24.5 |
| 2 | 16 | 12 | 16.0 |

By reference to the table of natural flows, storage, etc., under Group 2, it is seen that no storage is required between Apr. 11 and May 8, and between July 6 and July 19, since double the natural flow in each stream is far more than required to flume Group 3 in the 5% and 2% grades. The natural flow in one stream during these periods is more than is needed to flume along the 1% grade. The 68 hours fluming means less than 8 days of 9 hr. each. The period for fluming Group 3 would occur, therefore, between May 4 and May 8 and between July 6 and 11.

In the foregoing data 3 in. crook of log and 2 in. clearing has been allowed. To find the allowable curvature of the flume Table IX has been prepared for the case of the tract of timberland in mind.

## Summary of Results

(1) Fluming would be feasible.

(2) It could occur in three years between May 4 and July 19.

(3) The length of the sides of the flume would be 41 in. on the 1% grade, 41 in. on the 5% grade and 43 in. on the 2% grade.

(4) Some 1615 M. ft. b.m. of lumber would be required irrespective of the bents.

(5) The allowable horizontal and vertical curvature is 26° on the 1% and 5% grades, and 41° on the 2% grade provided the flume does not curve both horizontally and vertically at the same place.

TABLE VII.

| Grade per cent. | Ratio of displacement per cent. | Volume of water sec. ft. | Total sec. ft. | Depths inches | Lengths of sides inches | Lumber M feet B.M. Per Mile | Total |
|---|---|---|---|---|---|---|---|
| 1 | 26 | 79 | 99 | 30.0 | 47 | 120 | 600 |
| 5 | 12 | 130 | 146 | 26.0 | 41 | 111 | 117 |
| 2 | 19 | 82 | 98 | 27.0 | 43 | 113 | 904 |
| Grand Total | | | | | | | 1615 |

TABLE VIII.

| Date | Nat. Flows each stream sec. ft. | Period days | Storage flow sec. ft. | Filling reservoir hours | Draining reservoir hours | Fluming period Number | Total hr. |
|---|---|---|---|---|---|---|---|
| April 11 | 17 | | | | | | |
| April 12 | 17 | | | | | | |
| April 13 | 17 | | | | | | |
| April 14 | 17 | 7 | 25 | 3.6 | 2.4 | 14 | 26.6 |
| April 16 | 17 | | | | | | |
| April 17 | 17 | | | | | | |
| April 18 | 17 | | | | | | |
| April 19 | 18 | | | | | | |
| April 20 | 18 | | | | | | |
| April 21 | 18 | 5 | 23 | 3.4 | 2.6 | 10 | 21.0 |
| April 23 | 18 | | | | | | |
| April 24 | 18 | | | | | | |
| April 25 | 19 | 1 | 0 | 3.2 | 2.9 | 2 | 4.8 |
| April 26 | 20 | 1 | 0 | 3.0 | 3.2 | 2 | 5.4 |
| April 27 | 22 | 1 | 0 | 2.8 | 4.8 | 2 | 7.0 |
| April 28 | 26 | 1 | 0 | 2.3 | 8.6 | 2 | 9.0 |
| April 30 | 30 | 1 | 0 | 2.0 | 11.0 | 2 | 9.0 |
| May 1 | 34 | 1 | 0 | 1.8 | 11.0 | 2 | 9.0 |
| May 2 | 32 | 1 | 0 | 1.9 | 11.0 | 2 | 9.0 |
| May 3 | 29 | 1 | 0 | 2.1 | 11.0 | 2 | 9.0 |
| May 4 | 26 | 1 | 0 | 2.3 | 8.6 | 2 | 9.0 |
| May 5 | 23 | 1 | 0 | 2.6 | 4.6 | 2 | 7.9 |
| May 7 | 22 | 2 | 0 | 2.8 | 4.0 | 4 | 14.0 |
| May 8 | 22 | | | | | | |
| May 9 | 21 | | | | | | |
| May 10 | 21 | | | | | | |
| May 11 | 21 | 6 | 17 | 2.9 | 3.5 | 12 | 36.0 |
| May 12 | 21 | | | | | | |
| May 14 | 21 | | | | | | |
| May 15 | 21 | | | | | | |
| May 16 | 22 | 1 | 15 | 2.8 | 4.0 | 2 | 9.0 |
| May 17 | 29 | 1 | 1 | 2.1 | 11.0 | 2 | 9.0 |
| May 18 | 35 | 1 | 0 | 1.7 | 11.0 | 2 | 9.0 |
| May 19 | 40 | 1 | 0 | 1.5 | 11.0 | 2 | 9.0 |
| May 21 | 49 | 1 | 0 | 1.2 | 11.0 | 2 | 9.0 |
| May 22 | 51 | 2 | 0 | 1.2 | 11.0 | 4 | 18.0 |
| May 23 | 51 | | | | | | |
| May 24 | 52 | 1 | 0 | 1.2 | 11.0 | 2 | 9.0 |
| May 25 | 58 | 1 | 0 | 1.0 | 11.0 | 2 | 9.0 |
| June 20 | 45 | 1 | 0 | 1.4 | 11.0 | 2 | 9.0 |
| June 21 | 40 | 1 | 0 | 1.2 | 11.0 | 2 | 9.0 |
| June 22 | 54 | 1 | 0 | 1.1 | 11.0 | 2 | 9.0 |
| June 23 | 56 | 1 | 0 | 1.1 | 11.0 | 2 | 9.0 |
| June 25 | 47 | 1 | 0 | 1.3 | 11.0 | 2 | 9.0 |
| June 26 | 44 | 1 | 0 | 1.4 | 11.0 | 2 | 9.0 |
| June 27 | 41 | 1 | 0 | 1.5 | 11.0 | 2 | 9.0 |
| June 28 | 40 | 1 | 0 | 1.5 | 11.0 | 2 | 9.0 |
| June 29 | 38 | 1 | 0 | 1.6 | 11.0 | 2 | 9.0 |
| June 30 | 37 | 1 | 0 | 1.6 | 11.0 | 2 | 9.0 |
| July 2 | 32 | 1 | 0 | 1.9 | 11.0 | 2 | 9.0 |
| July 3 | 31 | 1 | 0 | 1.9 | 11.0 | 2 | 9.0 |
| July 4 | 29 | 1 | 1 | 2.1 | 11.0 | 2 | 9.0 |
| July 5 | 27 | 3 | 5 | 2.2 | 11.0 | 6 | 27.0 |
| July 6 | 27 | | | | | | |
| July 7 | 27 | 1 | 7 | 2.3 | 3.6 | 2 | 9.0 |
| July 9 | 26 | | | | | | |
| July 10 | 25 | | | | | | |
| July 11 | 25 | 4 | 9 | 2.4 | 6.7 | 8 | 34.0 |
| July 12 | 25 | | | | | | |
| July 13 | 25 | | | | | | |
| July 14 | 24 | 1 | 11 | 2.5 | 5.5 | 2 | 7.5 |
| July 16 | 23 | 1 | 13 | 2.6 | 4.6 | 2 | 7.4 |
| July 17 | 22 | 2 | 15 | 2.8 | 4.0 | 4 | 14.0 |
| July 18 | 22 | | | | | | |
| July 19 | 21 | 1 | 17 | 2.9 | 3.5 | 2 | 6.0 |

TABLE IX.

| Group | Largest Diameter inches | Log Length feet | Grade per cent. | Depths inches | Least flow sec. ft. | Clearance inches | Allowable curvature deg. |
|---|---|---|---|---|---|---|---|
| 1 | 32 | 16 | 1 | 24.5 | 58 | 2 | 41 |
| | | | 5 | 24.5 | 130 | 2 | 41 |
| | | | 2 | 24.5 | 82 | 2 | 41 |
| | 26 | 24 | 1 | 24.5 | 58 | 5.2 | .. |
| | | | 5 | 24.5 | 130 | 5.2 | .. |
| | | | 2 | 24.5 | 82 | 5.2 | .. |
| | 23 | 18 | 1 | 17.5 | 26.5 | 2 | 33 |
| | | | 5 | 17.5 | 59.0 | 2 | 33 |
| | | | 2 | 21.3 | 59.0 | 4.6 | .. |
| | 22 | 16 | 1 | 17.5 | 26.5 | 2.5 | 62 |
| | | | 5 | 17.5 | 59.0 | 2.5 | 62 |
| 2 | | | 2 | 21.3 | 59.0 | 5.0 | .. |
| | | | 1 | 17.5 | 26.5 | 3.6 | 80 Ap. |
| | 20 | 20 | 5 | 17.5 | 59.0 | 3.6 | 80 " |
| | | | 2 | 21.3 | 59.0 | 6.0 | .. |
| | | | 1 | 17.5 | 26.5 | 4.6 | .. |
| | 18 | 24 | 5 | 17.5 | 59.0 | 4.6 | .. |
| | | | 2 | 21.3 | 59.0 | 7.0 | .. |
| | | | 1 | 12.0 | 11.0 | 2.0 | 26 |
| | 16 | 20 | 5 | 12.0 | 24.5 | 2.0 | 26 |
| | | | 2 | 14.7 | 24.5 | 3.8 | .. |
| 3 | | | 1 | 12.0 | 11.0 | 4.0 | .. |
| | 12 | 24 | 5 | 12.0 | 24.5 | 4.0 | .. |
| | | | 2 | 14.7 | 24.5 | 5.8 | .. |

**A Novel Form of Negligence,** on the part of an engine driver, was responsible for the Vauxhall Station collision, on the London & Southwestern Ry., in England, noted in Engineering News, Sept. 5, 1912, p. 461. In the official investigation of the accident it was brought out that the engine driver thought that he was running on a local track whereas in fact he was on an express track. He observed, then, only the local track signals, which showed an open track, while the express track signals were at danger to protect a passenger train ahead.

In consequence he met the train ahead on a curve when he had not time to slow down and the collision resulted. There are eight tracks in the section where the wreck occurred and there seems to have been some confusion in the placing of the signals, although this is the first instance of such inadvertence on the part of a driver. He is a man of long service and good record.

**Balanced Swinging Lifts** for transferring canal boats from one level to another, have been recently proposed instead of locks by two separate concerns in Europe and designs, similar in scope, but different in detail, have been given out for the projects, though there seems to be no immediate prospect of their being built. In each of these designs there is a tower lying in plan adjacent to the upper and lower level, which are not in alignment, and balanced on this tower is a swinging framework extending over both levels. This frame carries at its ends a closed tank capable of holding a canal boat. In practice, this tank, opened at its entering end, is moved up or down into the level where the boat is, the boat is run into the tank, which is then lowered or raised to the other level where the boat is let out.

In one of the designs the frame is pivoted on a float in an upper level adjacent to the canal upper level and the tank is dropped into both canal levels and opened afterward. In the other the frame is pivoted on a masonry bearing located between the two levels and while the tank is dropped into the lower level, it is brought up to the same elevation as the upper level and a watertight connection between the tank and the level made. This latter design provides duplicate transfer of boats, that is, each tank is balanced by a similar one on the other end of the frame, so that when one tank is on the lower level to the right of the frame, the other tank is at the upper level to the left of the frame. The former design has only one tank, which is balanced by a counterweight.

The first named design was made by the "Société d'Augsbourg-Nuremberg" for a 36-m. difference in level on the Oder, the second by Schoen and Schoszberger, and is for a similar rise. Descriptions of the two designs appeared in the "Zeitschrift für Binnen-Schiffahrt," May 15, 1912, and the "Oesterreichische Wochenschrift," Aug. 8, 1912.

# Concrete Pile Footings for the 42-Story L. C. Smith Building, Seattle, Wash.

The L. C. Smith Building now under construction in Seattle, Wash., is the highest office building to be built outside of New York City and is surpassed in number of stories by only two buildings in that city, although there are four or five that surpass it in height. As shown in the architect's sketch in Fig. 1, it will be of the tower type made familiar by several of the more recent New York skyscrapers, with a 21-story main building surmounted by a tower having 12

FIG. 1. THE L. C. SMITH BUILDING, SEATTLE, WASH.

("The Highest Building Outside of New York." 42 Stories, 416 Ft.)

stories in its main section and nine stories in the pyramidal peak. From the curb level on the low side of the building to the top of the steelwork is to be 461 ft.

In the original design it was intended to carry the 50 columns of the building on grillages resting on spread footings which were to be founded on the clay bottom some 20 ft. below the lowest curb level. Accordingly excavation was started last winter and in its progress revealed what seemed to be an exceptionally good clay capable of sustaining the 4½ tons per sq.ft. (dead load only) for which it was designed. On reaching the approximate elevation of the footings, test loads were applied and while some of them were satisfactory, others showed so low a bearing power as to lead to an investigation, by borings, of the substrata below the excavation.

The site was originally occupied by one-story brick buildings with very shallow footings. The bulk of the excavation below these footings was composed of volcanic material, containing sand and pumice thoroughly cemented together, but readily excavated by pick and shovel. This ground was remarkably stiff and remained standing in cut to nearly a vertical line. In fact, in the first excavation steps were cut in the side of the earth to permit the workmen to get in and out of the hole. In Fig. 4, two such columns of earth may be noted in the left background. As the excavation went lower, however, pockets of sand, clay and pumice pebbles began to appear and the banks were braced by the shoring shown in Fig. 4.

In the investigation of the substrata five borings were made in different parts of the pit. The locations of these are shown in Fig. 2 and the sections through them in Fig. 3. It will be observed that at the northern end of the excavation, there is, at the footing elevation (compare elevations in Fig. 3 and Fig. 5), a surface stratum of clay, some 9 ft. thick at the extreme north corner but sloping upward so that at the northwest corner it is but 6 ft., while at the center of the plot, in boring No. 3 it has disappeared altogether and the outcrop is a black sand which appears as the top stratum through the rest of the plot, as shown in borings No. 2 and No. 1. Furthermore the borings showed the ground to be successive layers of sand and clay and of a nature not adapted to spread footings.

A number of schemes for the solution of the footing problem were then considered. The principal one was to use solid concrete footings sunk with pneumatic caissons to the clay layer shown as 8.75 ft. thick about 20 ft. down in boring No. 2. The thickness of this layer was so variable that its stability as a foundation was questioned and the project abandoned. As a final solution it was then decided to foot each column on a group of concrete piles driven through the successive strata to the clay layer noted above, that is, to about 20 ft. below the bottom level of the concrete or Elev. −12.

Although a large part of the foundation could have been held successfully on spread footings, all the columns footings were supplied with concrete piles in order to insure a uniform condition over the whole area. Most of the piles were designed for a load of 27 tons, though a few carried 30 tons. They were spaced at intervals of from 2 ft. 6 in. to 3 ft., forming groups under each of the columns, with an average unit pressure on the whole area of ground in each group amounting to about 4 tons per sq.ft. In all, 1276 piles were called for, though a few more were used, owing to some changes in design.

The footings themselves consisted of crossed I-beams resting in concrete on the piles, of the general type shown in Fig. 5. Some of the footings were joined together, in which cases riveted plate girders were used to distribute the loads to the concrete bases. The piles used in the work were of the filled shell type patented by the Raymond Concrete Pile Co.

The material to be penetrated consisted of cemented volcanic material, pockets of clay, gravel and sand which made it impossible to drive piles without jetting. About 125 lb. water pressure

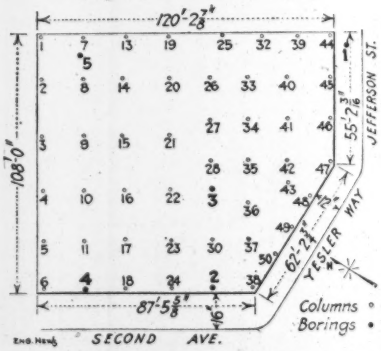



FIG. 2. PLAN OF FOOTINGS OF L. C. SMITH BUILDING, SHOWING LOCATION OF BORINGS

was available from the city supply and a 4-in. connection delivering water through a 4-in. meter and a 3-in. hose and jet pipe gave sufficient volume and velocity of water through a 1-in. nozzle to jet this material. The time required for jetting varied considerably on account of the lack of uniformity in the materials encountered. In some cases the large pockets of clay to be penetrated before reaching the sand made the jetting very slow. On account of the comparative hardness and toughness of the materials encountered, it was found that the work was materially accelerated by the use of a special nozzle having a tool-steel cutting edge surrounding the nozzle proper, thereby permitting the material to be readily jetted before being washed up with water from the jet. It also prevented the point of the jet becoming imbedded and suddenly shutting off the water in the line, thereby throwing considerable strain on the hose and piping.

The contract for this work was signed on Apr. 22, 1912, and the first pile was driven on May 3. Two complete pile-

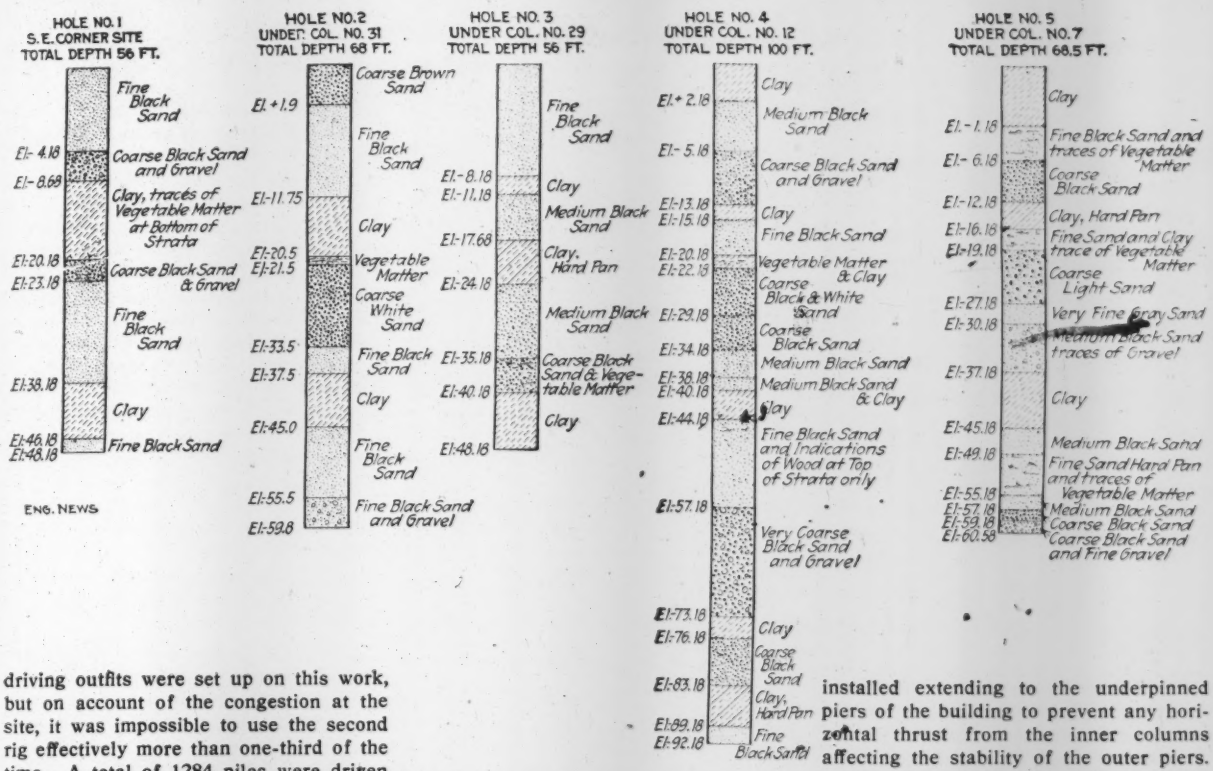



FIG. 3. BORINGS AT SITE OF L. C. SMITH BUILDING

(Location shown in Fig. 2)

driving outfits were set up on this work, but on account of the congestion at the site, it was impossible to use the second rig effectively more than one-third of the time. A total of 1284 piles were driven and the lengths averaged about 20.65 ft.

The method of driving was to jet a hole to a layer of hardpan, which was about 20 ft. below the surface from which the driving was done, then drop the pile core and shell into it as promptly as possible and drive to firm resistance. The sand and water resulting from jetting adjacent piles flowed over the pile already driven, surrounding it with sand, and the water was then pumped out by means of two motor-driven centrifugal pumps. Considerable excess sand resulted from the jetting work, which was removed after the majority of the piles had been driven. The ground being practically incompressible, it was necessary to remove a column of material practically equal to the volume of pile shell to be driven.

The degree to which the soil was compressible is shown by the fact that without jetting it was possible to drive only about 4 ft. 6 in. The work was rather complicated for a number of reasons. The excavation was about 22 ft. below the curb on one side and averaged about 35 ft. below the curb on the opposite side. The lot is situated at the corner of Second Ave. and Yesler Way, in the heart of the city. On one side of the lot was a two-story store which it was necessary to underpin and brace. On another side of the lot was a narrow alley separating the building site from the seven-story Arctic Club building. The row of piers next to the alley were underpinned to the approximate grade of the bottom of the excavation. The face of the excavation along the alley side was sheeted and braced and direct braces were installed extending to the underpinned piers of the building to prevent any horizontal thrust from the inner columns affecting the stability of the outer piers.

After many unforseen delays, due to the excavating, shoring and bracing and due to court order stopping night work, the entire 1284 piles were driven on Aug. 3.

Although piles were jetted within 2 ft. of the footings of the two-story building and within 7 ft. of the footings of the

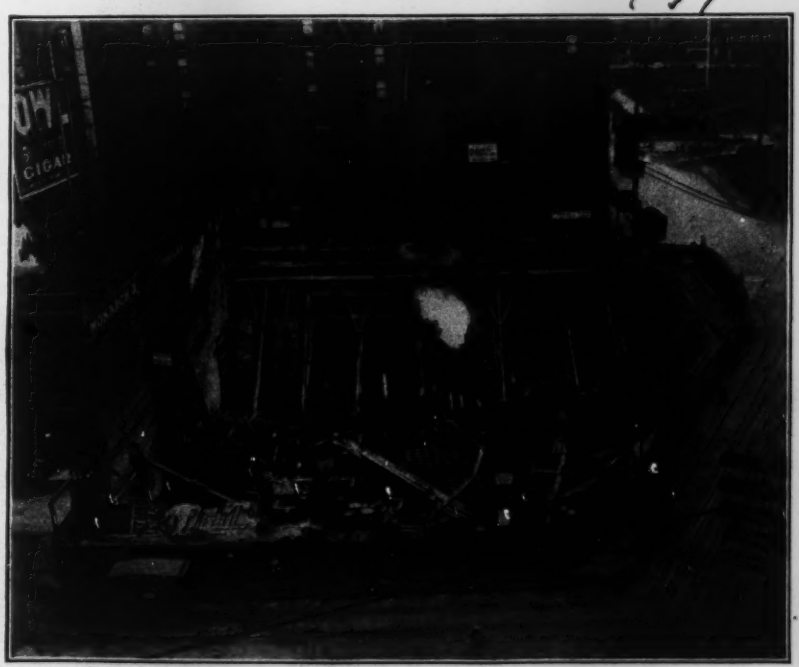


FIG. 4. VIEW DURING DRIVING OF PILES

seven-story building, no settlement on either building was detected and the entire number of piles were driven without damage of any kind to adjacent buildings.

Fig. 4, from a photograph taken June 29, shows the work about half completed and gives some idea of the congestion and difficulty of the work. In the upper left-hand corner there appears more material still to be excavated. The light colored material is volcanic, the darker material toward the bottom is very firm clay, which was mainly in the pockets, and an overlaid stratum of black sand. The tank and grillage shown in the center were used for making loading tests. The tank was of 15,000 gal. capacity and afforded ready means of loading and unloading by means of water to 60 tons.

The piles used were standard Raymond concrete piles placed in the following manner. From a No. 1 Vulcan steam hammer hanging in the pile driver leads was suspended a collapsible metal core, measuring 8 in. in diameter at the point, 20 in. in diameter at the top and 30 ft. long. Over this core was tightly drawn a sheet-metal shell with a pressed-steel boot covering the end of the core. After jetting a hole this core and shell were dropped into place and driven to firm resistance. The core was then collapsed and withdrawn, leaving in the ground a hole the exact shape and size of the core, lined with a sheet-metal shell. This retained the compression and resistance of the surrounding soil, and prevented admixture of water, mud, sand and form materials, while the concrete, which was placed in the shell, was setting. The shell was filled to the approximate grade required and was cut off at the exact grade after the concrete was firmly settled.

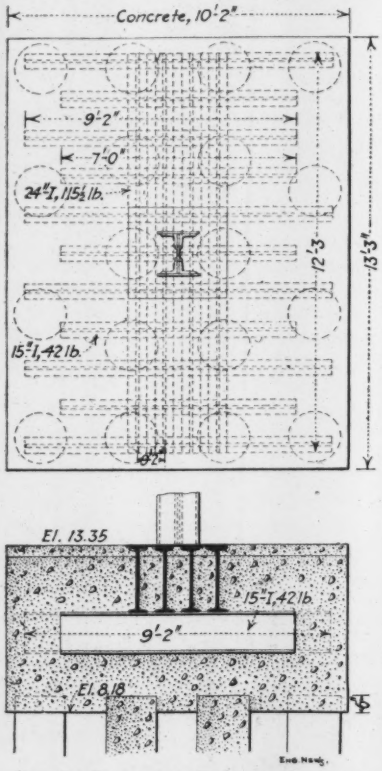



FIG. 5. DETAIL OF TYPICAL COLUMN FOOTING

After they were placed the piles were tested under load, and showed a settlement under load of 60 tons per pile varying from ⅛ in. in the case of the best clay substrata to 2⅝ in. in the softest. As they were designed for a maximum load of 30 tons, this was considered satisfactory, and the construction of the superstructure was proceeded with.

The L. C. Smith Building is being built by Burns Lyman Smith, of Syracuse, N. Y., and is named after his father, the founder of the large typewriter business that bears his name. It will be built according to the latest ideas of high-building construction and will loom up from afar in a city where the present highest building, outside of church spires, is barely one-quarter as high. It was designed and is being superintended by Gaggin & Gaggin, architects, of Syracuse, N. Y., and is being built by the Whitney Co., of New York City. Chr. J. Jeppesen, of New York City, was the consulting engineer under whose supervision the concrete-pile foundation was designed and built, and the piles were placed by the Raymond Concrete Pile Co. Balcom & Darrow, also of New York City, are the engineers for the steel structure.

# Letters to the Editor

## A Flood-Proof Bridge

Sir—In your issue of Sept. 12, 1912, p. 508, is a description of the flood that swept Brooke County, W. Va., on the night of Sept. 1, 1912, involving a loss of 20 lives, together with great property damage. Included in the property loss were four steel railroad bridges, and 11 highway bridges, in Brooke Co., and 35 steel bridges in the adjoining county of Washington, in Pennsylvania.

Midway between Colliers and Hollidays Cove, over Harmons Creek in the direct path of the flood was a 60-ft. span reinforced-concrete arch completed Aug. 3, 1912, less than one month before the flood, by the Luten Bridge Co., of York, Penn. This arch is flood proofed by a 6-in. concrete pavement across the bed of stream from abutment to abutment, the pavement being reinforced with embedded steel ties which also unite the abutments to resist the thrust of the arch.

The flood rose to a height of 8 ft. above the roadway over this arch, but the structure itself was barely damaged, although trees, houses and débris of all kinds were dashed against it. The appearance of the bridge after the flood is shown in the accompanying view, the only damage being to the 6-in. concrete railing and to the earth fills of roadway and approaches.

LUTEN BRIDGE CO.,
By L. G. BROWN,
President.

York, Penn., Oct. 29, 1912.

REINFORCED-CONCRETE ARCH NEAR COLLIERS, W. VA., AFTER PASSING THROUGH A FLOOD 8 FEET ABOVE ROADWAY

## A Partly Completed Concrete Dam Unharmed by Flood

Sir—During the night of Oct. 23, 1912, a reinforced-concrete dam, now being built in the gorge of the Cuyahoga River, near Akron, Ohio, by the Northern Ohio Power Co., was exposed to an extremely severe test.

Heavy rains during that day and evening increased the flow of the river to such an extent that serious damage was anticipated from floating logs and débris, and a gang of men was kept busy all evening removing the logs from the pond above the dam. When it was thought that all danger was over, a wooden dam about two miles up the stream gave away and an enormous volume of water, filled with the débris from this dam and a large amount of driftwood which had been held above this dam came down the river at about 4 o'clock on the morning of Oct. 24.

It was stated that the river at this point rose about 4 ft. in as many minutes. The concrete for the upper part of the deck, which had been poured only a day or two before, received the full impact from this mass of water, logs, etc. The excellent quality of this concrete is shown by the fact that after the flood had subsided, the only damage found was a few cracks here and there, in this fresh concrete, while the remaining portion of the dam was not damaged in the least.

The accompanying halftone shows the appearance of the dam from above a few days after the flood. It will be noted that the floating débris carried by the flood bent over all the reinforcing rods projecting from the uncompleted buttresses.

This dam is about 450 ft. wide at the top and has a height of 52 ft. from the bed of the stream to the top of the spillway. Near the bed of the stream under the spillway, four 48-in. pipes have been placed and provided with gate valves, which can be opened if it should ever be desirable to empty the reservoir. Up to this time these pipes have been kept open. They were unable to take care of such a flood as the recent one, and although they have now been open for over a week, the level of the pond has not dropped more than 6 or 8 ft.

This dam is being built to impound water for condensing purposes for a 40,000-kw. steam power station, which the company now has under construction. The water will also be used under a head of about 100 ft. in a hydraulic power station about one-half mile below the dam.

The contractors for this work are the Carmichael Construction Co., of Akron, Ohio, operating under a license from the Hydraulic Properties Co., of New York, who control the "Ransome" patents, according to which the dam is built.

J. C. LATHROP.

Akron, Ohio, Oct. 31, 1912.

VIEW OF UPSTREAM FACE OF PARTLY COMPLETED DAM ON CUYAHOGA RIVER NEAR AKRON, O.

## International Technical Congresses and Their Usefulness

Sir—Referring to your editorial on "The Results Attained by the Congress of the International Association for Testing Materials," which appeared in your issue of Sept. 19, 1912, the writer wishes to express his views, not upon especially the general subject of the usefulness of International Congresses, but upon one which he is quite sure you would not have included in the following remarks except that you did not wish to draw any invidious distinctions:

> The conviction has long been entertained by many careful observers of society and convention matters that organizations of very large scope, particularly those of international scope, have little value beyond their social side. . . .
>
> We have no desire to single out the Testing Congress as a special object of criticism, but . . . similar remarks would hold as to any of the other recent international technical congresses.

The writer refers to the International Congress of Navigation, which has recently for the first time held its session in the United States.

At the official function at Ottawa, presided over by the Minister of Marine and Fisheries, in the Chateau Laurier, being called upon for some remarks, the writer took occasion to outline the methods of the Navigation Congress. There is given following some of these features as there expressed, which will explain the fact of the effectiveness of this particular international congress and show why it produces useful results affecting the many countries interested in it, along all the important lines of ocean and inland navigation, results that have enlarged and improved the ways of navigation and developed the facilities of commerce, along the sea coasts, at the entrances of harbors, in the arrangement of ports, in facilities for handling cargo, and in devising the best facilities for inland navigation on rivers and canals, and is directly affecting the size of maritime canals and the lock entrances to the ports of London, Liverpool and other ports worked under great fluctuations of the tide.

> I wish now to take this favorable opportunity, when so many leading men of your government and of your commerce are before me, to explain in some details the operations of the International Navigation Congress. It is supported by the annual contributions of the governments of 40 countries, including the Danubian and Suez Canal Commissions.
>
> The membership comprises 49 countries. Up to 1894 there had been held periodically two congresses, one maritime navigation and one inland navigation. They might be called ephemeral, for they dissolved after the sessions of each congress, but in 1894, at the Hague, the two congresses met jointly and decided to constitute a permanent joint organization under the name of the "International Congress of Navigation," and to meet in 1898 at Brussels to perfect the permanent organization. The Belgian navigation and commercial men had taken a lively interest in the project and the Belgian Government was ready to support it.
>
> The congress of 1898 developed the project, which was perfected in Paris in 1900. . . .
>
> . . . The Permanent International Commission, meeting at Brussels, selects the subjects to be reported upon two years in advance of the meeting of the congress. These subjects have been previously suggested from the different countries and the Commission endeavors

to select subjects of live interest, which have not been hitherto discussed and decided upon at previous congresses.

The National Committee members of the Permanent International Commission in the different countries, select the writers, one only for each subject, which are called "Questions," or "Communications." At the Philadelphia Congress there were three questions and three communications in each of the two sections, Inland and Maritime, and there were about 120 papers in all.

In the country where the congress is to be held the committee of that country selects General Reporters—reviewers. When these preliminaries are arranged the subjects are written upon in each country, in papers not to exceed 20 pages of 400 words each and with a limited number of plates. They are sent to Brussels, where the executive committee of the Permanent Commission has them translated and printed in the three language of the congress—French, German and English. They are then sent out to the entire membership of over 2000 scattered over the whole world. A set of each paper on each subject is given to the General Reporters, who write a synopsis of the papers submitted to them, and they at the end of their reports give the consensus of opinion of the writers and close with suggested conclusions for the congress to adopt. These General Reports are sent on to Brussels, translated into the three languages and printed, with the suggested conclusions in italics. These are then sent out all over the world to the membership.

When the congress assembles later on it is unnecessary to read any papers, not even the résumé of the General Reporter, but only his "Conclusions," which are discussed in the section meetings. They are adopted or changed or perfected, as the Section in the discussions decides to be necessary, and they are then voted upon, and again voted upon by the whole congress at its last general meeting of the congress. There is issued each morning a "Journal" of the congress, giving full information about the previous day's work.

When the congress adjourns, all the discussions, decisions and other information about the congress are sent on to Brussels, where a volume of the proceedings is issued to supplement the papers already published. This volume is also printed in the three languages of the congress and is then sent out to the entire membership.

I think you will agree with me in the opinion that the results of such a congress, its literary product, is of incalculable value to the navigation interests of the entire world, for the decisions of this congress of practical experts have weight everywhere where Inland or Maritime Navigation works are to be built, operated or maintained. . . .

To give one instance of practical benefits: the results of the discussions at these congresses upon the size of ocean vessels to be provided for have had a direct effect upon the present designs of the Kaiser Wilhelm Canal and the London Docks, making their capacity far superior to that of the Panama Canal, the various commissions of which, for some unaccountable reason, have not been influenced by the International Navigation Congress and have consequently made two false steps, one in pronouncing the dictum that locks 900 ft. by 95 ft. were large enough for merchant and naval vessels of the future, and later, in making the final width 100 ft. only. Even the width of 110 ft. insisted upon by the U. S. Naval Board is already restricting the safe width for the large "superdreadnought" being designed by the U. S. Navy Department.

As long ago as 1905 it was shown plainly at the Navigation Congress held at Milan that the most optimistic predictions of future size had been greatly exceeded by ships built up to 1904, and this should have been sufficient warning.

If the results of discussion by the Navigation Congress are not considered of sufficient importance for adoption, it is not the fault of the Congress, but of engineers who evidently considered themselves able to act without the advice of an international body of experts.

As to the results elsewhere, there are plenty of instances that may be brought forward to substantiate the statement that practical results of great importance come from the discussions of the International Navigation Congress. It is within the personal knowledge of the writer that the size of entrance channels to the harbors and the depths of ports of Argentine, Uruguay and Brazil are due entirely to the depths considered necessary by the International Navigation Congress.

There is another point made in your editorial with which the real facts do not agree.

You state that the papers "might have found ample publicity through other channels," and again "nothing, in other words, that would not have been secured through the ordinary mediums of discussion, through the technical press or through local engineering societies."

On the assumption that these remarks apply to international congresses generally, the general consensus of opinion will not approve. The papers and discussions before an engineering society in St. Petersburg or Lisbon or Rome, in Russian, Portuguese and Italian, would scarcely reach the United States even through such excellent organs as ENGINEERING NEWS. They would be disseminated in these languages in the country of their origin, but generally not beyond it, and so would really be lost to the world at large.

The papers and discussions on important navigation subjects, the literary product of the Navigation Congress, go in English or German or French (take your choice) to 49 countries and to a membership in them of over 2000 permanent members, in a language which they can read; so it all works to uniformity and harmony of ideas and methods. Again the very fact that the governments of 40 countries financially support the Navigation Congress and send their delegates to the triennial congresses and to the annual meetings of the Permanent Commission at Brussels is proof of the favorable opinion of these governments of the great practical usefulness of the congress.

As to the International Congress for Testing Materials, it is necessary to explain some features with which the writer, being a member and having had something to do with it and international railway and road congresses, is somewhat familiar. This congress is in close association with the International Road Congress, the International Navigation Congress, and the International Railway Congress, and its specifications and work are advantageous to all these congresses.

One of the principal difficulties which you refer to, but do not explain, is the radical divergence of views in Europe, South America and the United States in respect to specifications, especially of many metal products. The South American engineers and railway men are generally inclined to come to Europe for their products, as they believe in the thorough testing methods, and what appear to us to be severe requirements, employed in Europe, particularly in Germany. Possibly if American engineers and railway men would be more severe in their requirements and tests there might be fewer broken rails, and bored holes might be safer than punched holes in bridge members.

Without an international organization to give an opportunity for engineers of all countries to come together and discuss their differences, there never will result an accord in constructive materials between the producing countries of the world. With such an organization there is some hope of eventual harmony in tests and of the adoption of standards.

E. L. CORTHELL.

Hotel Bernerhof, Bern, Switzerland,
Oct. 12, 1912.

## Notes and Queries

The article on Street Railway Track Reconstruction at Vancouver, B. C., in our issue of Sept. 26, was accompanied by a foot-note referring to the use of a somewhat similar method of breaking up concrete street foundations at San Francisco. We are informed that the engineers in charge of the work at Vancouver devised their methods and designed their concrete-breaker without reference to the work at San Francisco.

**Mineral Oil Exports** from the United States, during the fiscal year 1912, are valued at $112,000,000. Fifty years ago, in 1862, when the first statistical record was kept, the value of these exports was about $1,500,000. The range of distribution of these products is perhaps wider than for any other American goods. Over 80 different countries and colonies are supplied with some or all of these products, Europe being by far the largest consumer.

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# Engineering News

## The Highest Building in the World Outside of New York City

The financial success of the L. C. Smith Bldg., at Seattle, Wash., the foundations to which are described on another page of this issue, will be watched with interest. It has generally been understood that the owners of the very high tower buildings in New York City have had to write off a large annual sum charged to advertising in order to bring their net receipts up to a fair rate of interest for the money invested in the buildings. While this fair rate of interest is undoubtedly always based on an inflated valuation of the land occupied, it remains without doubt that the cost of construction and operation increases very rapidly with increase beyond a reasonable height. Additional height involves extra weight in the lower stories and demands additional material, which means higher original cost and more difficult erection, while at the same time it requires more room for structural and traffic purposes, thus decreasing the income-bearing area.

It is only in the most congested metropolitan areas that the land becomes so valuable as to require so multiplied a use of its area and, as we have said, even then the added glory of extra height must bear a large portion of the expenses. How, then, can a 42-story building, in a town where the highest similar structure is now but 12 stories, be considered as anything but an economic misfit, unless perchance, it serves to boom the sale of its owner's typewriters, or possibly to increase the value of some of his now none too valuable surrounding land? Or is it possible that the well-known intense rivalry of our Pacific seaports has led to such extremes as a highest-building-outside-of-New York subsidy?

## The Record-Breaking Activity in Shipping and Shipbuilding

At a time when business is active in all parts of the United States, it is of interest to record that an equally notable wave of prosperity is prevalent on the other side of the Atlantic. In the United States the iron and steel trade is often called the barometer of business. In Great Britain, with its enormous shipping and shipbuilding interests, prosperity and business activity is closely indicated by the freight rates obtainable in the world's carrying trade on the high seas and by the activity in the construction of vessels.

At the present time, ocean freight rates the world over are higher than they have been for many years. A recent issue of the *London Times* says:

> Probably there has never before been a time when ocean freights were so uniformly good. There have been periods when particular trades gave fine results, but today in practically every route rates are very firm. Higher prices are now being paid to bring maize from Argentine than have ever before been recorded. Grain is being brought from the Pacific Coast of North America at rates which are approaching double what were accepted a year ago. So firmly are vessel owners now standing out for good terms that chartering of a vessel is often very difficult. There has been particularly a famine in tank steamers available for the shipment of oil in bulk.

The rapid expansion in the use of petroleum in Europe has progressed faster than the supply of tank steamers to carry the oil. There is, of course, a certain amount of risk in building tank steamers. A ship of this construction can be used only in the oil trade and is not available for general cargo purposes at any time when there is not enough oil freight offering to keep the tank steamers busy. Those connected with the petroleum-producing interest, therefore, are straining every nerve to complete a sufficient number of tank steamers to enable the supply of oil to keep pace with the demand.

It is well to point out that this period of prosperity in the ocean-shipping trade affects chiefly the owners of freight-carrying vessels. In passenger service, rates are changed little from season to season. The margin of profit in passenger traffic is comparatively small anyway, as is shown by the returns of the great shipping companies of the world. Expenses of the passenger trade, moreover, have been seriously increased by the stringent rules as to vessel construction and equipment, which are to be put in force as a result of the "Titanic" disaster. The demand for greater luxury as well as greater safety in passenger travel at sea also exerts a steady pressure toward increase of expense.

The classic remark of the American railway magnate who said he would rather carry hogs than commuters is quite applicable to the ocean-carrying trade. The railway magnate intended no invidious reflections upon either the hogs or the commuters. He merely preferred to carry the traffic which yielded the greatest profit. The profits in freight transportation on the high seas

under present conditions are far beyond those possible in the passenger service.

Naturally the high profit in the shipping trade is reflected in a most active demand for new ships and in busy shipyards. London *Engineering*, of Oct. 11, reported that the shipbuilding now in progress in the yards of Great Britain and Ireland exceeds all previous records. The total number of vessels now in progress is 587, representing a total tonnage of 2,341,367 tons. This is an increase of 25% over the tonnage of vessels under construction one year ago. Ship yards are experiencing difficulty in getting workmen enough to keep pace with the demand, and many yards are working overtime and double shifts. Not only is the activity in shipbuilding unprecedented, but the prospects of future activity are promising. Orders for new vessels are coming in faster than the completed vessels are turned out of the yards.

It is of interest to note that while shipbuilding in the United States represents no such great proportion of our manufacturing industry as in England, American shipyards are also full of business.

## A Movement to Restrict International Exhibitions

The burdens placed upon manufacturers of engineering appliances by participation in exhibitions have long been realized to be a more or less serious matter. In the United States the exposition craze seems to have died out for the time being. The practical failure of the Jamestown Exposition has discouraged other cities from attempting similar extravagances.

In Europe, however, not a year passes but one or more international expositions are held in some country or other, and it has come to be a practical question as to how far the governments of the different countries should countenance such expositions. It can be readily understood that where an exposition is backed by one of the principal powers of Europe, conditions of politics and diplomacy make it virtually compulsory that other nations shall not refuse the invitation to join in making the exposition an international affair. Hitherto in Europe, as in the United States, international expositions have occurred whenever any particular city made up its mind to hold one and secured the backing of its national government.

But in Europe as here, it has come to be generally appreciated that to hold such expositions too frequently destroys their influence and importance and they no longer serve as landmarks to record industrial and scientific progress.

This question has become of such importance that four years ago the German government invited a conference of representatives of the principal commercial nations looking to a common understanding as to the regulation and limitation of international exhibitions. After several postponements such a conference was held last month in Germany; and it is stated by our London contemporary, *The Engineer*, that the governments officially represented included Great Britain, the United States, Japan, France, Belgium, Denmark, Holland, Italy, Austria, Russia, Spain, Sweden, Switzerland and Germany. The proceedings of the conference were private and the decisions arrived at will probably not be known until they are officially promulgated.

From one point of view it may seem a small matter for the governments of the world to undertake to regulate the holding of international expositions. On the other hand, such great events as the Crystal Palace Exhibition in London, the Centennial Exposition in our own country, and the first great Paris exposition had undoubtedly a great influence in promoting peace and international good feeling and in stimulating the development of science and industry. While the development of technical literature and technical societies has to a considerable extent done away with the necessity for expositions as a means of education, it is still true that international expositions held at not too frequent intervals and properly conducted may be of great value to the world.

## An Opportunity for Cooperation in Engineering Exhibitions

If it is worth while for the governments of the world to coöperate for the regulation of international expositions, may it not be worth while for the engineering industries of the United States to coöperate in the holding of industrial expositions?

American manufacturers of engineering appliances are put to heavy expense annually for participation in the various exhibitions which have come to be an important part of the annual meetings of some of the very large technical organizations. The display of railway appliances, for example, at Atlantic City during the week in June in which the Master Car Builders' and Master Mechanics' conventions are held is equal to that which one might expect to find at an international exposition of considerable prominence. This display is made, moreover, for the benefit of a very small number of visitors.

Exhibitions almost or quite as large and expensive form a part of the annual Street Railway Association's convention and of the National Electric Light Association meeting, while exhibits of considerable size are made at probably a dozen other engineering conventions. For the smaller firms especially, participation in these various exhibitions is often a very serious burden and one from which the profit is hard to trace. Most of the firms who take part in these exhibitions do so because they feel compelled to do as their competitors do.

If by some means a certain measure of coöperation could be brought about between the different technical organizations so that their meetings could be held at the same place during different weeks throughout the summer and fall, it would be possible by combining all these different exhibitions in one to create an annual industrial exhibition covering all lines of engineering that would be equal or superior to what one would find in a great international exposition. Participation in such an exposition lasting the whole season should be very little, if any, more expensive than the present cost of participating in the expositions made at a society convention which lasts only a week or so.

Such an exposition moreover would attract a hundred engineers for every one who now visits the exhibits made at the various society conventions. The educational value of such exhibits to the engineering profession and the engineering industry generally would be multiplied many fold by such a combination as is here suggested.

We understand that the Hotel Men's Association of Atlantic City stands ready to take the lead in financing such an enterprise. All that is needed is an agreement among the different technical societies to coöperate with respect to the time and place of holding their convention. The great benefit to all classes of engineering and engineering industry which could be brought about in this way should make it possible to secure such coöperation.

## Facts Concealed in a Railway Freight Receipt

A group of men sat in the smoking room of a Pullman car discussing current political and economic issues. The lead in the conversation was taken by a campaign "spellbinder," and when the discussion turned to the high cost of living he played over the bunker as follows:

"It's the railways that are to blame for this high cost of living. Everything you eat and everything you wear and everything you buy the railways bring from somewhere, and charge you freight for carrying it. So for every dollar you pay out for your living, part of it has to go to the railways. They are great big wealthy corporations. They ought to carry you cheaper where you want to go, and charge you less for carrying your freight. They ought to pay their men more wages, and they ought to fix up their tracks and run their trains so that they wouldn't have so many accidents. The trouble is railways ain't half run. They say that if one of these scientific management sharks had the job of

running the railways, he could save them about a million dollars a day."

Among the group who heard this indictment of the railways there was one man who had hitherto been a silent listener.

This man now took a slip of yellow paper from his pocket and after scanning it a moment, replied to the spellbinder:

"The trouble with you and me, my friend," said he, "is that we believe what we read or what we hear somebody say; and it never occurs to us to use the thinking machine under our hats and dig out the truth for ourselves from the facts that are lying right around us.

"Of course, it's true that almost everything that comes on your table, that your clothes and the materials for them, and all the materials that the farmer and the miner and the manufacturer uses, are all carried on the railway. It costs money to carry them, so the railways have to charge you and me freight. But if you think the rates that the railways charge for freight are excessive, just take an ordinary waybill and study it with common intelligence and see what sort of a lesson it will teach you.

"Here, for instance, is a freight bill which I received just as I left home. Four bundles of steel rods, weighing all told 365 lb., were shipped from a mill in Pittsburgh to my home in a New Jersey suburb of New York City. This bill shows that the railway carried these bundles of steel, weighing a little over a sixth of a ton, all the way from Pittsburgh to New York, about 450 miles, and then out to the suburb where I live, and that it charged me the sum of *sixty-nine cents*. Then when these rods arrived at the railway station they were put on a truck and carted three-quarters of a mile to my house, and this bill shows that I paid the truckman for this job the sum of *fifty cents*.

"Perhaps you will say that we ought to build good roads, so that it wouldn't cost so much to haul freight to and from the railway stations; and I'll not deny that; but it happens in this case that the road from the railway station to my house is well paved all the way. Further, while the railway company out of its sixty-nine cents paid the cost of keeping up its railroad, in the case of the hauling from the station to my house, I had to help as a taxpayer to keep up that road, for the truckman and everyone else to use. So the 50c. I paid for cartage is only part of what it cost me to have that steel hauled from the railway to my house.

"Perhaps you'll say that the truckman ought to modernize his business; but it happens that he delivered that steel with an automobile truck. Perhaps you will say that he charged too much for what he did; but his charge is just typical of what you and I and ten million other people are paying every day with never a thought of protest. I'm traveling now a distance of a hundred miles, for which I pay the railway, including a seat in this car, about $2.50; but I will pay in hack fares and baggage transfers for being carried with my trunk about a mile at each end of my railway journey about two dollars, or as much as the railway charges me for carrying me and my baggage the whole hundred miles.

"There is nothing exceptional or extraordinary about this waybill. You may pick up any old waybill, and if you study it intelligently and fairly, it will teach you the same lesson. It will tell you that in the average town and city in the United States, it costs as much to transport the food and merchandise and building materials and all the things that enter into the cost of living from the railway station in the town to the point where they are to be finally used as all that is paid to the railway for bringing the things from where they are originally produced to the town itself. Whether it be a bushel of potatoes, a pound of sugar, a yard of cloth, or a barrel of lime, there will be as much expended in transportation back and forth between various dealers and its final delivery to the consumer inside the city limits as all that is paid to the railway for bringing it from farm, or mine, or factory all the way to the town.

"Instead of the railway being responsible for the high cost of living, it is the railway that has annihilated distance and has made it possible to carry food products thousands of miles and then sell them at a moderate price. Stop all railway traffic entering a city for a single week, and see what prices the necessaries of life will reach.

"Now there is another thing that I want to say about your idea that the railways aren't well managed. We hear loose talk about the railways losing a million dollars a day by bad management, and great numbers of people—more's the pity—believe it. You hear people talking about having the government operate the railways, as if that would make sure that they would be well managed.

"Let's ask this little slip of paper whether the railways are efficiently managed or not. Let's see what the railway did to earn that sixty-nine cents I paid it. In the first place, a railway company through one of its freight agents in Pittsburgh received these four bundles of steel and made out a complicated receipt, in which it agreed to carry them to their destination and to be responsible for their safety. Somebody in the railway service had to decide by what route the shipment should travel, and somebody had to pick out a car going in the right direction and to the right destination on that route and order a freight handler to put the shipment in that car.

"The car was finally loaded with perhaps half a hundred similar small shipments of merchandise, a shifting locomotive was attached to it and shunted it back and forth through a maze of yard tracks until it was finally placed in proper position in an outbound freight train on the Pittsburgh & Lake Erie Ry. Over this railway the shipment traveled 103 miles to Andover, Ohio. Here it was transferred to a branch of the Lake Shore & Michigan Southern Ry. It continued farther north on this branch until it reached the main line at Ashtabula and then it traveled 129 miles eastward to Buffalo. Here it again changed hands, being placed in the custody of the Delaware, Lackawanna & Western R.R. This company hauled it 410 miles to its terminal at Hoboken, and then 14 miles further on a suburban branch to its final destination.

"Thus this shipment of four bundles of steel, each of them weighing about 90 lb., was carried a total distance of 681 miles for the sum of 69c. The railroad paid for the manual labor of loading it into the car at Pittsburgh and taking it out of the car when it reached its destination. The chances are that in addition these bundles were handled by manual labor two to four times during the journey in transferring them from one car to another, all of which the railways paid for.

"Strict account was kept by the railways of this shipment, and the total amount received (69c.) had to be equitably divided between the three railway companies which performed the service. In this charge of 69c. is included not only all the expense of operating the railway, wages of freight handlers, station agents, locomotive engineers, train crews, yard employees, fuel for locomotives, and all the thousand and one items that go to make up the operating expenses of a modern railway, but in addition the profit necessary to pay the interest on the railway's bonds and the dividends to its stockholders, without which our railways would go into bankruptcy and their efficient service would be at an end.

"I know something of what 'scientific management' can accomplish in reducing the cost of production in factories; but I do not know of any greater miracle in modern industry than that which the modern railway system has wrought in rendering transportation service at low cost.

"You hear it said very frequently, too, that the railways favor the large shippers and that it is not possible for the small man to do business any longer because his big competitor can ship his freight so much more cheaply. It is true, of course, that the railways make a lower rate on shipments in carloads than they do on shipments like the small lot of merchandise to which this waybill refers. They *have* to do this because it costs them very much more to handle small shipments.

As a matter of fact, I suspect that if careful investigation were made, it would be found that the railways are carrying a great many of their less-than-carload shipments at less than what it actually costs them. Their profits are chiefly made on the shipments which are loaded into a car at their origin and carried through to their destination without breaking bulk."

"Don't you think the government ought to run the railways?" queried one of the group of listeners, as the speaker paused for a moment.

"The government ought to do what it is now doing," he replied, "see that the railway treats all its patrons alike and plays no favorites, and that it gives good service at reasonable rates. After the government has done this, it should keep its hands off and let the railways do the very best they can.

"I have no small prejudices against government ownership of railways. The German railways are run by the government and are run well; but the German government can do things which we make a sad muddle of in this country; witness the government of German cities compared with our own. And when you make careful comparison, I believe our American railway systems are managed as efficiently and economically as any railways in the world. Of course, they are not perfect; nothing anywhere is perfect. Least of all can it be claimed that work done under government methods with their necessary red tape is perfect. On the whole I believe the men who are running our great American railway systems, from president down to track walker, are doing honest, efficient, economical work, and that the American public ought to appreciate this fact and give the railways a square deal."

# Failure of the City Reservoir Wall, Nashville, Tenn*

BY HOWARD M. JONES†

The reservoir which provides the pressure for the water supply of the city of Nashville, Tenn., is located in the southern part of the city on what is known as Kirkpatrick's Hill, which rises sharply on all sides from the surrounding territory. The bottom of the reservoir is 277 ft. above the low water of the Cumberland River, from which stream the water is pumped. The capacity of the pumping station with all pumps operating is about 40 million gal. daily, and the capacity of the reservoir is 50 million gal. The average daily consumption of water from the reservoir is about twelve million gal.

This reservoir, the construction of which was described in ENGINEERING NEWS, June 16, 1888, p. 484, is elliptical in plan, the major axis being 603 ft. and the minor axis 463.4 ft., and is divided into two equal compartments by a cross wall along the minor diameter. Fig. 1 shows the general plan of the reservoir and a typical section at the point of failure. It was completed in 1889 and has been in continuous service since.

The original article describing the reservoir has the following account of the foundations and structure:

As a site for the new reservoir a bald hemispherical-shaped hill was selected, lying south and easterly from the city and distant about 1½ miles from the Capitol. The hill is composed of a limestone rock in horizontal layers of varying thickness, and covered in places with earth and clay. On account of the rock being so near the surface, and also to secure increased head, it was decided to build above ground, the water being confined by a stone dam, as is shown in section in Fig. 2. The walls are being constructed with the stone excavated at A, while the earth, clay and refuse rock taken from the center are dumped just outside the foundations of the walls, as shown at B, thus forming a driveway, from which a very beautiful view of the surrounding country is obtained.

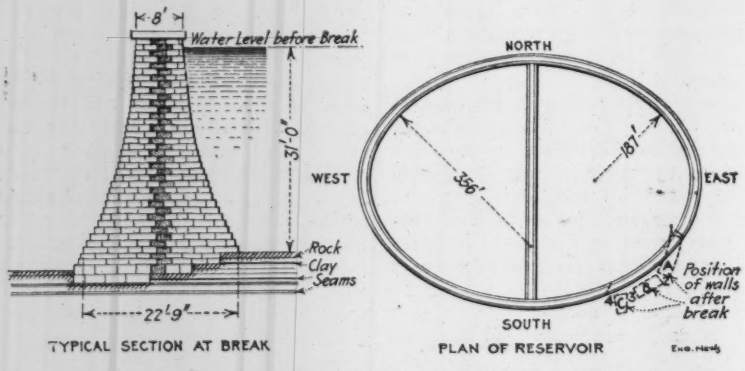



FIG. 1. PLAN AND SECTION THROUGH WALLS OF NASHVILLE RESERVOIR WHICH FAILED NOV. 4, 1912

The walls were built of local limestone, ranged rubble work, laid in natural cement mortar, there being an irregular space vertically near the middle portion of the wall, averaging about 15 ft. thick, which was made entirely of natural cement concrete, this core evidently being put in for the purpose of assisting in making the walls watertight. At the top of the wall a cut-stone coping course was laid.

As will be seen by inspection of the cross-section in Fig. 1, the bottom of the wall did not all rest on one ledge of the rock, but it was stepped outwardly. These steps were very irregular, there seeming to have been no effort at all to have the bottom uniform around the wall. At some sections there are no steps at all, the bottom all being carried down to the same ledge; at others there were several steps running from a few feet beneath the inside of the wall to within a few feet of the outside wall. A masonry course was brought up to level of top of each step and then the next course carried on to the natural rock, etc., until the masonry had been brought to the level of the bottom of the reservoir, at which point the true section of the wall was begun and accurately carried out in construction. Although originally it was intended to put in a concrete floor to the reservoir, it does not appear to have been placed.

At 12:10 midnight of Nov. 4, 1912, a section of this wall on the southeast side about 150 ft. in length was moved outward and broken at four different places.

FIG. 2. METHOD OF CONSTRUCTING RESERVOIR

(Material from A put in walls. Spoil placed at B and B)

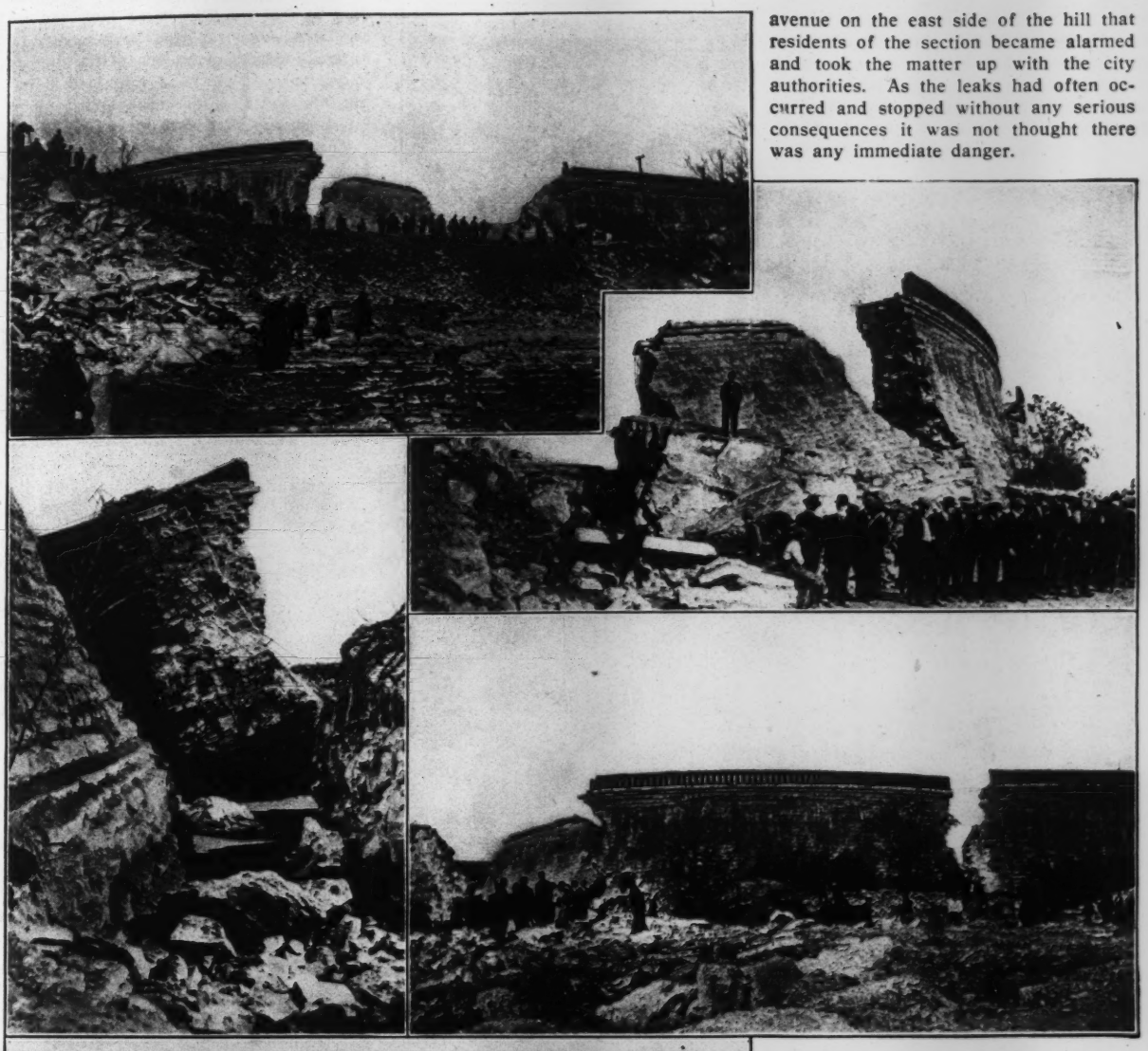
At the time the reservoir had 25 million gal. of water in it, with a depth of 31 ft. This water rushed through the breaches in the wall and down the steep hillsides, carrying with it earth, rock, trees, houses and everything else in its path. The water divided in three distinct streams, flowing in different directions, thus greatly lessening the damage to property in the vicinity.

When the water was first admitted to the reservoir in 1889 it was found to leak badly, but after working on the joints and bottom for some time it was finally made pretty tight. However, from time to time new leaks have developed, and there have been some minor leaks at all times. Several days before the accident occurred, one of these leaks became very much worse and was flowing so freely down the hillside and across the

*The views in Figs. 3-7 were furnished us by A. F. Gaines, of the Nashville, Chattanooga & St. Louis Ry.; Mr. Jones forwarded the remaining views.

†Consulting Engineer, Nashville, Tenn.

avenue on the east side of the hill that residents of the section became alarmed and took the matter up with the city authorities. As the leaks had often occurred and stopped without any serious consequences it was not thought there was any immediate danger.



FIGS. 3-6. VIEWS OF THE COLLAPSED WALL

FIG. 7. VIEW LOOKING DOWNHILL FROM RESERVOIR SHOWING HOUSES MOVED 200 FT. BY WASH

(The house in the middle of the view and the one behind it, to the left, were washed from a position near the telephone pole in the left foreground)

The following statement of a member of the Board of Public Works of the city shows the attitude of the responsible governing party: "I had talked to several residents in that section about the leakage and had mentioned the matter to the Superintendent of the water-works and Chairman of the Board. The Superintendent of the water-works lowered the water several days prior to the accident and patched up a lot of seams in the walls. We didn't regard the situation as serious, as there had been a leakage from the time the reservoir was constructed."

Residents describe the breaking of the walls as accompanied by a mighty roar like the rush of a cyclone, which awakened the sleeping inhabitants for blocks around. The watchmen on the reservoir say the first warning they had of the disaster was when this first loud report

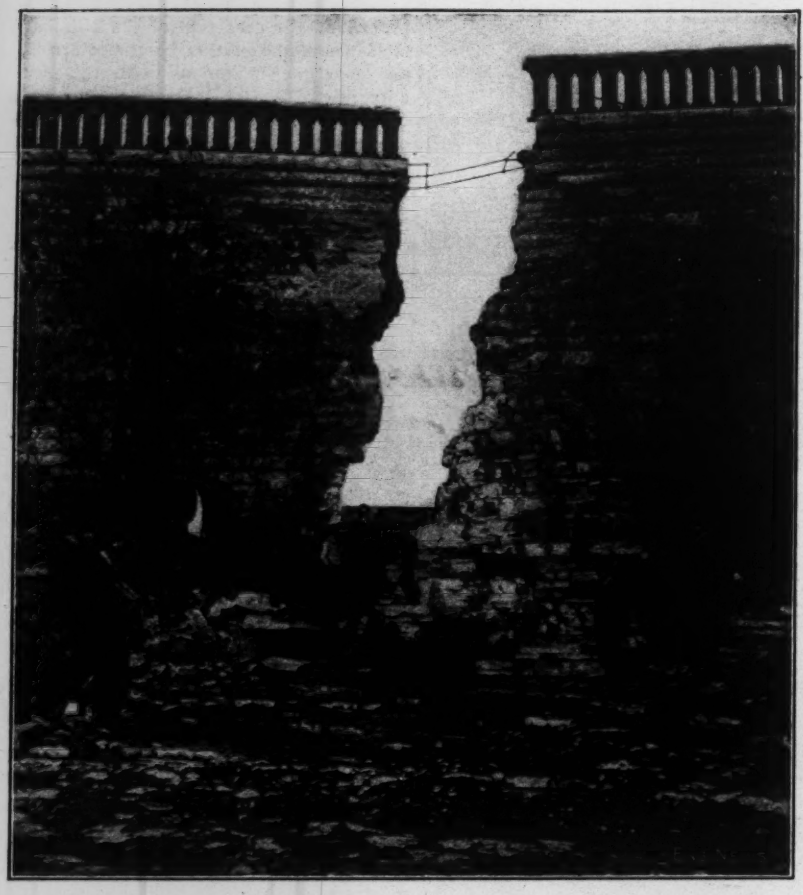


FIG. 8. VIEW OUTSIDE OF BREAK AT A (FIG. 1) SHOWING IN THE FOREGROUND CHARACTER OF FOUNDATIONS

occurred. They rushed immediately out of their house, which is on top of the walls at one end of the division wall, and saw water rapidly passing out. They state it required probably 30 minutes for all the water to flow out.

As stated above, when the reservoir was built a large portion of the top of the hill was excavated. This excavation was almost entirely rock of a very poor quality. Large waste banks of this material were made all around the brow of the hill at some distance from the reservoir walls, as shown in the sketch in Fig. 2. This material in itself helped to serve as a dam to check the rush of water. Great quantities of this loose rock were carried away by the water and completely buried the street-car tracks on Eighth Ave. to a depth of 6 ft. for about 200 ft. distance. A large number of frame cottages were bodily picked up off their foundations and moved in some cases several hundred feet, sometimes being turned completely around. The top soil in adjacent property was completely taken away, exposing rock, which was about 5 ft. underground, for many blocks distant. The fact that the water flowed away in three distinct channels localized the track of great devastation, and prevented what might otherwise have been a most appalling disaster. As it was, the property damage was great, but the most remarkable fact connected with this accident is that *no lives were lost*, and no one was even reported seriously hurt, although nearly every one of the houses in the path of the flood contained sleeping occupants, who were carried along in the houses that were moved.

The accompanying views give a clearer idea of just what happened, and the consequent results. On Figs. 8 and 10 the character of the foundation rock particularly should be noted. The captions of the different views explain them.

The remaining half of the reservoir was not injured and is serving the city, so that no water famine is likely to occur.

### CAUSE OF FAILURE

On the morning after the disaster the writer made a careful examination of the broken walls and the foundation bed on which they had rested. Section A (Fig. 1) of the wall was about 75 ft. long, the north end being slightly inward from the original position and the south end of this section being about 30 ft. outwardly from its original position. Section B of the wall was about 50 ft. in length and had been moved about 30 ft. from its original position and the inner edge, having no doubt come to a stop over the hole washed out beneath the bottom, dropped in this hole, causing the wall to lean very perceptibly inward, as may be seen in the views. Section C, about 25 ft. in length, was turned completely over by the rush of water and part of it was broken off and carried 500 ft. away.

The breaks at points 1, 2 and 3 (Fig. 1) were practically vertical and at right angles to the axis of the wall. The masonry showed no evidence of any disintegration nor were there any signs of any percolation through the walls above the bed of the reservoir, except at point 4, where percolation had evidently been going on through the wall itself to a

FIG. 9. LEANING SECTION B (FIG. 1) AND SECTION C OVERTURNED AT RIGHT
(Note Berm of Spoil Rock in Background)

height of 6 ft. above the floor of the reservoir. But even at this point the masonry had not been weakened to any extent. The mortar joints and the core of concrete were in magnificent condition, and the walls above the floor of the reservoir gave every evidence of having been carefully built.

As much cannot be said for that portion of the masonry which was put in to level up the unevenness of the footing courses. This masonry was not so well built, and the junction of the inside of the walls with the floor of the reservoir was not made in such a manner as to exclude the percolation of the water underneath the bottom of the walls. The water followed along the natural rock bed, and destroyed any bond the masonry might have had with the natural rock. The exposed bottom of Sections A and B of the wall shows clearly that they had no bond of consequences to the foundation bed. Where a good bond did exist, however, as was the case at several points, the walls carried the natural rock bed along with them when they moved outwardly.

At point 2 (Fig. 1), underneath the outside part of the wall, was a natural rock ledge 6 in. in thickness and underneath this ledge was an earth or shale seam about 3 in. in thickness. There were thinner clay seams between the ledges of all the rock on which the wall was founded. Water percolating through the bottom of the reservoir no doubt found its way through these clay seams, thoroughly saturating them.

In the writer's opinion, the above noted clay seams had become thoroughly saturated with water and had consequently softened so that the pressure on the outside edge of the wall caused the clay to squeeze out. The thin rock ledges were then not strong enough to support the wall and they were broken off successively. The wall then dropped down on what was practically a lubricated surface and slid outwardly on the clay seam.

No definite evidence could be secured as to just where the first break occurred, but it is the writer's opinion that it happened at point 2, and that the other breaks followed immediately afterward.

The primary cause of the failure was no doubt the failure to stop the leakage from the reservoir, through the floor of the reservoir and underneath the walls. While it was not possible to examine the floor of the reservoir on account of its being covered with a deposit of mud, the writer is informed it was the original intention to make it in a manner similar to that used in making the foundation for the walls; that is, by stepping off ledges and bringing the floor to a uniform level by putting in concrete, but that after the bottom was thus leveled up there was no concrete floor put in covering the entire bottom. It is a self-evident fact that however the bottom was put in, it did not stop the leakage.

FIG. 10. VIEW OF BOTTOM OF WALL

(The portion on the right is a view of a part of Section A, Fig. 1, and shows the lack of bond to the underlying rock, while that on the left of the picture is a part of the bottom of Section B to which a lot of the natural rock is still attached and moved with the wall)

## A South American Railway Consolidation

A syndicate composed of English, German, French and American bankers has purchased a controlling amount of stock in the Argentine Railway Co., and the lines of this railway will be consolidated under the same general management as the Brazil Railway Co., which already controls practically all the railways of that country, Uruguay and Paraguay.

The Argentine railways included in this system are the Argentine North Eastern (665 miles), the Entre Rios Rys. (688 miles), the Central Cordoba (992 miles), the Cordoba & Rosario (180 miles) and the Rosario & Puerto Belgrano (480 miles). The Santa Fé Provincial Ry. may also enter into the combine, in which case the total number of miles controlled by the Argentine Ry. will be 4091 miles. Of these railways the Argentine North Eastern and the Entre Rios are 1.435 m. gage and the others 1 m. gage.

The Brazil Railway Co. owns and controls 4742 miles of track now in operation and is building 1818 miles more. The Brazil Railway Co. also owns a controlling interest in the Paraguayan Central Ry. (232 miles) and of the Uruguayan Rys., which have a total length of 1443 miles. The same interests, which are all under the direction of Percival Farquhar, President of the Brazil Railway Co., of New York City, also control the Antofogasta (Chili) & Bolivia Ry. (769 miles).

The entire system of which Mr. Farquhar is the head therefore consists of railways in the different countries in the southern part of South America as follows:

| | Miles |
|---|---|
| In Argentina | 3005 |
| In Brazil | 6560 |
| In Paraguay | 232 |
| In Uruguay | 1443 |
| In Chili | 769 |

Or a total of 12,009 miles—or 13,000 miles, if the Santa Fé Provincial Railways be included.

The connection with the Antofogasta line, which is also narrow gage, will be made at some convenient point, probably on the frontier between Argentina and Bolivia in the neighborhood of La Quica.

When all these systems are linked up, there will be a perfect railway system uniting the whole of Southern Brazil with Argentina, Uruguay, Paraguay, Bolivia and Chili, extending from the Atlantic to the Pacific and terminating at the great ports of Buenos Aires, Bahia Blanca, Rio Janeiro, Montevideo, Rio Grande, Santos, etc.

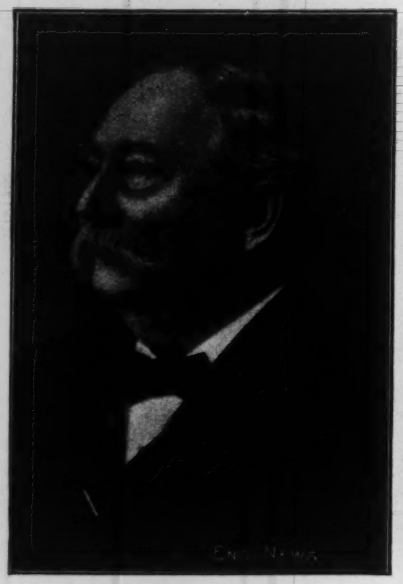
The controlling company, the Brazil Railway Co., is an American enterprise, incorporated under the laws of the State of Maine, and its general offices are in New York City.

Connected with the railway company are subsidiary organizations, including a

colonization scheme for the development of over 6,000,000 acres of land grants, a cattle and packing company, which owns 7,000,000 acres of land and 150,000 head of cattle, a lumber company which has already acquired 560,000 acres of pine timber land, and a hotel department which will build and manage houses in the principal South American cities. The Brazil Ry. also owns 50% of the stock of the Madeira & Mamoré Ry., a portion of which was recently opened.

## Reuben Wells

The death, on Nov. 8, of Reuben Wells, for many years Superintendent of the famous Rogers Locomotive Works, at Paterson, N. J., removes another one of the group of men who had most to do with the development of American locomotive engineering during the '80's and '90's. Mr. Wells would have been 84 years old had he lived until New Year's day.



REUBEN WELLS

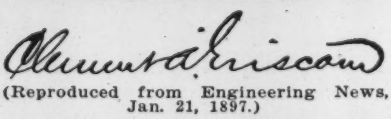
Mr. Wells was born Jan. 1, 1829, on a farm in Chester County, Penn. At the age of 17 he left the farm and began work as a machinist apprentice in the shops of the Reading R.R. After learning his trade, Mr. Wells began running a locomotive; but he soon went West and ran locomotives on the Columbus & Xenia R.R., and later on the Rushville & Shelby R.R. In June, 1852, when only 23 years of age, he was made Master Mechanic of the Jefferson & Indianapolis, which became later the "J., M. & J." (Jefferson, Madison & Indianapolis). He remained with that company for 26 years, and while there designed the locomotives for operating the famous Madison Incline (described in ENGINEERING NEWS, Vol. Jan.-June, 1897, p. 355).

In 1878, Mr. Wells became Superintendent of Machinery of the Louisville & Nashville R.R., and seven years later became General Manager of the system. It was locomotive engineering and mechanical work that interested him, however, rather than the executive responsibilities of railway operation, and after a short term with the Louisville & Nashville, in which he became assistant to the President, he was appointed, in 1887, General Manager of the Rogers Locomotive Works, at Paterson, with which his life was thereafter identified.

Mr. Wells is survived by a widow, two daughters and two step-sons.

## Clement A. Griscom*

Clement Acton Griscom, one of the founders and the first President of the Society of Naval Architects and Marine Engineers, died at his home in Philadelphia, Penn., Nov. 10. Mr. Griscom studied naval architecture and in his



(Reproduced from Engineering News, Jan. 21, 1897.)

early life was closely associated with the work of designing and constructing ships, but he was chiefly famous as a ship owner and financier, being one of the founders of the International Mercantile Marine Co., popularly called the shipping trust.

Mr. Griscom was born in Philadelphia, Mar. 15, 1841; his paternal ancestor, Andrew Griscom, came to America from England in 1680 as an associate of William Penn, and on the maternal side he was descended from Thomas Lloyd, Deputy Governor and President of the Council of the Province of Pennsylvania from 1684 to 1693. His father was Dr. John D. Griscom, a prominent Philadelphia physician.

After receiving an ordinary education in the public and private schools of his birthplace, in 1857 he became a clerk in the famous house of Peter Wright & Sons, shipping merchants, of Philadelphia. In 1863 he was admitted to membership in the firm, being at that time only 22 years old. To qualify himself for the management of the shipping and steamship business of the firm, Mr. Griscom studied naval architecture as applied to commercial vessels. He was one of the first in this country to recognize the growing ascendency of steam over sails for commercial purposes.

In 1891 the firm of Peter Wright & Sons organized the International Navigation Co., and Mr. Griscom was made its Vice-President. He was elected President in 1888 and retained this office until 1902, when he was associated with J. P. Morgan in forming the International Mercantile Marine Co., in which the International Navigation Co. was the chief element. Mr. Griscom was President of this great shipping combine until 1904, when he retired to become Chairman of the Board of Directors, and was succeeded as President by Bruce Ismay.

In addition to his shipping interests, Mr. Griscom was a director of the Pennsylvania R.R., the U. S. Steel Corporation, the Fidelity Trust Co., the Bank of North America, the Commercial Trust Co., the Fourth St. National Bank, the Mercantile Trust Co., of New York City, the Pennsylvania, New York & Long Island R.R., the National Transit Co., the New York, Philadelphia & Norfolk R.R., the United Gas Improvement Co., of Philadelphia, and several others.

*Based on a biography published in Engineering News, Jan. 21, 1897, at the time Mr. Griscom was elected President of the Society of Naval Architects and Marine Engineers.

**The 18-Hour New York-Chicago** trains on the Pennsylvania R.R. and the New York Central Lines are to be made 20-hour trains on and after Nov. 24, according to official announcements by the two railway companies. The change, however, is to be temporary and through the winter months only, and the reason given for lengthening the schedule is the increased difficulty of operation during the cold weather.

**Gas-Explosion Death Claim** — The Pintsch gas explosion in the battery house of the New York Central & Hudson River R.R. at 50th St. and Lexington Ave., New York City, on Dec. 19, 1910, has just led to a death-claim verdict against the railroad company for $8500 on account of one of the deaths resulting from the explosion. Many of the other claims have been settled before now, but this one came to trial by jury.

**The Steamer "Royal George" Was** wrecked in the St. Lawrence River, about 10 miles below Quebec, on the night of Nov. 6, and the lives of her 900 passengers imperiled. The boat is one of the fleet of the Canadian Northern Royal Mail Line and was making

her last trip of the season when she ran aground in a heavy fog, while traveling about 18 knots an hour. High winds and heavy seas combined to hinder the rescue work, although several tugs were sent, immediately after the accident, to lend any necessary aid.

**Service Pensions for Employees** have been established by the American Telephone & Telegraph Co. and subsidiary operating companies, and by its telegraph and manufacturing associates, the Western Union Telegraph Co., and the Western Electric Co. The general plans devised by Pres. T. N. Vail cover benefits for superannuation, accident and sickness of all employees.

Males of 60 years of age and over, or females of 55, who have seen 20 years' service or more, may retire on a pension which will be 1% of the average pay for the last 10 years multiplied by the number of years service. No pension will be less than $20 per month. An employee who has been 30 years in service may retire regardless of age on the approval of the president.

In case of total disability from accident at work and due to it, an employee will receive full pay for 13 weeks and half pay up to six years. During sickness or disability from accident outside of work, an employee having had 10 years or more service will receive full pay for 13 weeks and half pay for 39 weeks. If the service has been from five to ten years, full pay will be received for 13 weeks and half pay for 13 weeks more. If the service period has been from two to five years, full pay will be given for four weeks and half pay for nine weeks. Where the service has been of less than two years, heads of departments may continue pay during temporary illness at their discretion.

For death resulting from accident at work and due to it, an insurance amounting to three years' pay will be given to the dependents of the employee, the maximum payment being $5000. If the death results from sickness or outside accident, the insurance will be one year's pay for employees who have seen 10 years' service or more, and one-half year's pay for employees who have been from five to ten years in service, the maximum payment in either case being $2000.

In any state where statutes provide more liberal compensation, the statutory provision will prevail. Where the victims of accidents have legal rights, as in accident cases, they may either exercise their legal rights or accept the company's benefits.

The American Telegraph & Telephone Co. has set aside from its surplus a fund to provide for its own employees and to serve also as a reserve upon which the associated companies may draw under certain conditions. This fund is to be supplemented by the appropriations of each company involved. The total appropriations will aggregate something more than $10,000,000, it is announced, and the benefits will cost annually about $1,000,000 more than the present payments for this purpose. The administration of the funds will be in the hands of employees' benefit committees appointed by the boards of directors of each company.

**Pier Encroachment Halted**—Applications of the North German Lloyd, Hamburg-American, and Holland-American steamship lines, whose steamers dock at their own piers on the west bank of the Hudson River at Hoboken, N. J., for permission to extend their piers farther out into the river have been denied by Henry L. Stimson, Secretary of War. The applications had been examined by the New York Harbor Line Board (of Army Engineers), who reported that a temporary revocable license should be granted to the Hamburg-American line for an extension to adapt one of its piers to the size of its new mammoth steamer the "Imperator," to make its first trip next spring. Two years ago the then Secretary of War, J. M. Dickinson, granted a temporary permit of this sort to the White Star line, which occupies piers in the Chelsea group on the New York shore, the extension being asked as an emergency measure to provide for docking the "Olympic" and "Titanic" (the latter never reached this country). Secretary Stimson in his decision takes a strong stand against the policy of "temporary" encroachment, saying:

> A study of the successive encroachments on the river in the past shows that they have almost invariably been created under the plea of exigencies caused, like the present instance, by the growth in the size of the vessels visiting the port. . . . It seems to me that the limit of such encroachments has been reached. . . . . I therefore remit these applications to the New York Harbor Line Board, with directions to reconsider the matter with a view to its permanent decision and with instructions that no recommendations for temporary encroachments beyond the established pierhead line will be entertained by me. Notice also will be served upon the International Mercantile Marine Co. that the question of the continuance of its temporary extensions under the permits of Mar. 15, 1911, will be considered at the same time.

## Personals

Mr. Robert L. Milton has been appointed Superintendent of Terminals of the Wabash R.R., at Kansas City, Mo.

Mr. Asa H. Morrill, M. Am. Soc. C. E., has been appointed Engineer of Construction of the Boston & Maine R.R.

Mr. J. T. Hulehan has been appointed Assistant Superintendent of the St. Louis & San Francisco R.R., at Fort Smith, Ark.

Mr. D. A. Mathers has been appointed Assistant Superintendent of the Southern Pacific Ry. of Mexico, at Orendain, Mex.

Gen. Mario G. Menocal, a civil engineering graduate of Cornell University, class of 1888, has been elected President of the Republic of Cuba.

Mr. C. W. Gorsuch, formerly Assistant Superintendent of the Baltimore & Ohio R.R., at Pittsburgh, Penn., has been promoted to be Superintendent of the Newark division.

Mr. R. I. Wilby, formerly Assistant Engineer of the Toledo, Peoria & Western Ry., has been appointed Engineer of Maintenance-of-Way, with headquarters at Peoria, Ill.

Mr. Mandes Golder, Inspecting Engineer on the Penn St. viaduct, Reading, Penn., has resigned to become Assistant Engineer in the Bureau of Surveys, Philadelphia, Penn.

Mr. J. M. Warner, General Manager of the Chicago & Western Indiana R.R., has been elected Vice-President and General Manager of the Belt Ry. of Chicago, Ill., also.

Prof. B. F. Eyer, Assoc. Am. Inst. E. E., head of the department of electrical engineering at the Kansas State Agricultural College, has resigned to enter private practice.

Mr. C. P. Hammond, Assistant Engineer of Roadway of the Central of Georgia Ry., is now Engineer of Maintenance-of-Way. He will retain his headquarters at Savannah, Ga.

Mr. Arthur H. Tuttle has been appointed Engineer of Construction of the New York, New Haven & Hartford R.R., succeeding Mr. B. T. Wheeler, resigned, as noted elsewhere in these columns.

Mr. John T. Cheek, formerly Trainmaster of the National Rys. of Mexico, at Gomez, Palacio, Durango, Mex., has been appointed Acting Superintendent with headquarters at the same place.

Mr. Mott Sawyer, formerly Superintendent of the Bellingham Bay & British Columbia R.R., has been appointed Superintendent of Construction of the Chicago, Milwaukee & Puget Sound Ry., at Lewiston, Mont.

Mr. Sanford E. Thompson, M. Am. Soc. C. E., Consulting Engineer, of Newton Highlands, Mass., has established an office at 141 Milk St., Boston, Mass. His main offices and laboratory will remain at Newton Highlands.

Mr. Curtis N. Douglas, brother-in-law of Governor Dix, has been appointed a member of the Public Service Commission of New York, Second District, at a salary of $15,000 per annum, succeeding Mr. Winfield A. Huppuch.

Mr. Frederick H. Dewey, Engineer with Henry J. Hardenbergh, Architect, New York City, has been appointed Chief Inspector of the Bureau of Buildings, Borough of Manhattan, New York City, at a salary of $4000 per annum.

Mr. A. D. Caldwell, Supervisor of the Erie R.R., at Jersey City, N. J., has been appointed Division Engineer of the New York, Susquehanna & Western R.R., at Jersey City, succeeding Mr. J. W. Foote, transferred, as noted elsewhere.

Mr. H. Clewer, formerly Assistant Master Mechanic of the Chicago, Rock Island & Gulf Ry., at Fort Worth, Tex., has been appointed Superintendent of Locomotive Operation of the Chicago, Rock Island & Pacific Ry., with office at Chicago, Ill.

Mr. Wm. T. Lechlider, Assistant Superintendent of the Baltimore & Ohio R.R., at Cleveland, Ohio, has been promoted to be Superintendent of the same division, succeeding Mr. J. T. Johnson, who has been appointed General Agent of the company at Cleveland.

Mr. E. F. McCrea, Division Engineer of the Pennsylvania R.R., at Toledo, Ohio, has been transferred to Cincinnati, Ohio, succeeding Mr. G. Le Boutillier, transferred. Mr. G. R. Barry, Division Engineer at Zanesville, Ohio, succeeds Mr. McCrea at Toledo.

Mr. F. D. Nash, Assoc. M. Am. Soc. C. E., who has been in private practice for the past year at Reno, Nev., has accepted a position as Locating Engineer for the National Railway Construction Co., in Uruguay, and sailed from New York for Montevideo, on Nov. 9.

Mr. B. T. Wheeler, M. Am. Soc. C. E., Engineer of Construction of the New York, New Haven & Hartford and the Boston & Maine R.R., and Chief Engineer of the Boston Terminal Co., Boston, Mass., has been appointed Chief Engineer of the Maine Central R.R., at Portland, Me.

Mr. Burdette Moody, M. Am. Soc. C.E., of Pasadena, Calif., has been appointed consulting engineer of the new municipal water-works department of Pasadena at a salary of $3600 per annum. Mr. M. H.

Salisbury has been appointed Superintendent of the water-works department at a salary of $2400 per annum.

Mr. H. E. Brashares, formerly Signal Supervisor of the Chicago & Western Indiana R.R. and more recently Signal Inspector of the Great Northern Ry., at St. Paul, Minn., has been promoted to be Assistant Signal Engineer, succeeding Mr. C. A. Dunham, whose resignation was noted in our issue of last week.

Mr. W. B. Freeman, formerly District Engineer of the United States Geological Survey, and recently a consulting hydraulic engineer at Denver, Colo., has been appointed Irrigation Engineer for the Siamese Government, with headquarters at Bangkok, Siam. Mr. Freeman sails from New York on Nov. 15.

Mr. Calvin W. Hendrick, M. Am. Soc. C. E., Chief Engineer of the Baltimore, Md., Sewerage Commission, has been appointed Consulting Engineer for the city of Baltimore, in addition to his other duties, at a salary not to exceed $4000 per annum. As Chief Engineer of the Sewerage Commission Mr. Hendrick receives a salary of $10,000 per annum.

Mr. William D. Waltman, M. Am. Soc. C.E., Chief Engineer of The Cistilla Estates Development Co., San Acacio, Colo., has resigned to become General Manager of the Franco-Wyoming Oil Co., at Casper, Wyo. Mr. Waltman was connected with the Panama Canal construction for five years as Superintendent of the Porto Bello rock crushing plant and in other capacities.

Mr. W. D. Wiggins, Assoc. M. Am. Soc. C. E., Engineer of Maintenance-of-Way of the Pittsburgh division of the Pittsburgh, Cincinnati, Chicago & St. Louis R.R., at Pittsburgh, Penn., has been appointed Division Superintendent of the Vandalia R.R., at Decatur, Ill., succeeding Mr. F. L. Campbell, transferred. Mr. G. Le Boutillier succeeds Mr. Wiggins at Pittsburgh, Penn.

Mr. Ralph V. Fitting, Assoc. Am. Inst. E. E., Assistant Chief Engineer of the Electric Bond & Share Co., has resigned and is now associated with Harris, Forbes & Co., Bankers, of New York City, as Engineer. Mr. Fitting is a graduate of Leland Stanford, Jr., University, class of 1905, and for several years was with the engineering department of the Portland Gas Co., Portland, Ore.

Mr. J. W. Richardson has been appointed Chief Engineer of the Canton R.R. Co., Baltimore, Md. In 1904-05 Mr. Richardson was Principal Assistant Engineer in charge of surveys for the Bolivian Rys. (South America). Later he was Engineer in charge of terminals at Jacksonville, Fla., which position he left to become Chief Engineer of the Vera Cruz Terminal Co., Vera Cruz, Mex.

Mr. Harold Knight, formerly Division Engineer of the Erie R.R. at Salamanca, N. Y., has been appointed Engineer of the New York and Greenwood Lake division, the Northern R.R. of New Jersey and of the New Jersey & New York R.R. (subsidiaries of the Erie R.R.), with headquarters at Jersey City, N. J. Mr. Joseph W. Foote, Division Engineer of the New York, Susquehanna & Western R.R., at Jersey City, N. J., succeeds Mr. Knight at Salamanca.

Mr. Chas. H. Bigelow, M. Am. Soc. M. E., for the past two years Assistant Superintendent of Power and Plant, Yale & Towne Manufacturing Co., Stamford, Conn., has resigned to become Chief Mechanical Engineer of the Millville Manufacturing Co., Millville, N. J. Mr. Bigelow has recently returned from St. Catharines, Ont., where he had charge of the construction of a factory erected to care for the Canadian business of the Yale & Towne Manufacturing Co. Mr. Bigelow was formerly associated with Mr. Chas. T. Main, M. Am. Soc. M. E., Consulting Engineer, of Boston, Mass., and was also for several years with the department of motive power and machinery of the Boston Elevated Ry.

Mr. W. C. Downing, formerly Division Superintendent of the Vandalia R.R., at Terre Haute, Ind., has been appointed Superintendent of the Pittsburgh division of the Pennsylvania R.R. lines west of Pittsburgh, succeeding Mr. P. A. Bonebrake, transferred. Mr. Downing is a graduate of Earlham College and began railway work in 1885 as a rodman with the Pittsburgh, Cincinnati, Chicago & St. Louis R.R. In 1891 he was appointed Engineer of Maintenance-of-Way of the Richmond (Ind.) division. Mr. Downing has been connected with what is now the Vandalia R.R., since 1895, when he was appointed Engineer of Maintenance-of-Way. He was appointed Superintendent of the Peoria division in 1901.

Mr. W. M. Mitchell, General Manager and Chief Engineer of the Kentucky & Indiana Terminal R.R. Co., at Louisville, Ky., has resigned as General Manager and will resign as Chief Engineer when the construction work of the company now under way is completed. Mr. Mitchell has announced that he will organize an engineering and construction company in the near future. Many railway men have worked from the engineering department into the operating department, but Mr. Mitchell is one of few who have followed the opposite course and turned from the operating into the engineering and construction departments. He began railway work as a messenger boy at 15 years of age. He was successively brakeman, baggageman, freight and passenger conductor, yardmaster, general foreman and trainmaster on the Chicago, Burlington & Quincy R.R., the Minneapolis & St. Louis Ry., the Chicago & Northwestern Ry. and the Atchison, Topeka & Santa Fé Ry. In 1891 he was elected Railroad Commissioner of Kansas. From 1895 to 1900 he was Manager and General Superintendent of the St. Louis, Kansas City & Colorado R.R., and since 1902 he has been Manager of the Kentucky & Indiana Bridge & R.R. Co.

## Obituary

Eli Bates, Chief of the New York City Fire Department from 1873 to 1884, died at his home in Jersey City, N. J., Nov. 9. He was born in Orange County, N. Y., in 1825, and joined a volunteer fire company in New York City when he was 15 years old.

Samuel H. Cramp, former President of William Cramp & Sons, Shipbuilders, of Philadelphia, Penn., died at his home in that city Nov. 3, at the age of 79 years. He was one of three sons of William Cramp, founder of the firm, and was admitted to partnership in 1857. He was President of the firm 1897 to 1907.

## Engineering Societies

### COMING MEETINGS

RAILWAY DEVELOPMENT ASSOCIATION.
Nov. 17. Annual meeting at Cincinnati, Ohio. Secy., W. Nicholson, K. C. So. Ry., Kansas City, Mo.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 19. Annual convention at Washington, D. C. Secy., W. H. Connolly, Washington, D. C.

AMERICAN CIVIC ASSOCIATION.
Nov. 19-22. Annual convention at Baltimore, Md. Secy., Richard B. Watrous, Union Trust Bldg., Washington, D. C.

AMERICAN RAILWAY ASSOCIATION.
Nov. 20. Annual meeting at Chicago, Ill. Secy., W. F. Allen, 75 Church St., New York.

NATIONAL FOUNDERS ASSOCIATION.
Nov. 20-21. Annual convention at New York, N. Y. Secy., J. M. Taylor, 25 So. La Salle St., Chicago, Ill.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 21-22. Annual meeting at New York, N. Y. Secy., D. H. Cox, 29 W. 39th St., New York.

AMERICAN MINING CONGRESS.
Nov. 25-28. Annual convention at Spokane, Wash. Secy., J. F. Callbreath, Denver, Colo.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 2-3. Annual meeting at New York City. Secy., W. H. Ross, 154 Nassau St., New York.

NATIONAL COMMERCIAL GAS ASSOCIATION.
Dec. 2-5. Annual meeting at Atlanta, Ga. Secy., Louis Stotz, 29 W. 39th St., New York.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Dec. 3-6. Annual convention at Cincinnati, Ohio. Secy., E. L. Powers, 150 Nassau St., New York.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 3-6. Annual meeting at New York City. Secy., C. W. Rice, 29 W. 39th St., New York.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 4-6. Annual meeting at Detroit, Mich. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Dec. 5-7. Annual convention at Philadelphia, Penn. Secy., C. A. Prosser, 105 E. 22d St., New York.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 9-12. Annual meeting at New York City. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Penn.

NATIONAL ASSOCIATION OF CEMENT USERS.
Dec. 10-14. Annual convention at Pittsburgh, Penn. Secy., E. E. Krauss, Harrison Bldg., Philadelphia, Penn.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 26-28. Annual meeting at Chicago, Ill. Secy., C. O. Reed, Urbana, Ill.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 30-Jan. 6. Annual meeting at Cleveland, Ohio. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Jan. 14. Annual meeting at New York City. Secy., W. R. Ingalls, 505 Pearl St., New York.

**National Society for the Promotion of Industrial Education**—The Sixth Annual Convention of the Society will take place in Philadelphia, Penn., Dec. 5 to 7, at which time a number of important questions, bearing on the subject of vocational education, will be discussed.

The following are some of the more important topics to be treated: "Present Tendencies in Vocational Education"; "Teachers for Boys' Work"; "Teachers for Girls' Work"; "Federal Aid for Vocational Education"; "How to Open the Way for Vocational Education"; "Some Debatable Issues in Vocational Education," and "How to Get Team Work Between the Schoolmaster and the Layman."

# Engineering Literature

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## REVIEWS

### Iron and Steel Metallography

Reviewed by F. N. SPELLER*

THE METALLOGRAPHY OF IRON AND STEEL.—By Albert Sauveur, Professor of Metallurgy and Metallography in Harvard University. Cambridge, Mass.: Sauveur and Boylston. Cloth; 7¼ x 10¾ in.; pp. xv + 385; illustrated. $6, postpaid.

"The Metallography of Iron and Steel," by Prof. Sauveur, is the first work in English to treat this important subject with such completeness as it does. The book is characterized by novelty of treatment, breadth of purpose and general readability. The author has done much in the past to advance the knowledge of metallography which obtains today in this country, both by his editorial and academical work as well as by numerous contributions on the subject in the form of technical papers and reports. As one of the leading authorities and pioneers in metallography in America, he is well qualified to undertake a work of this class, and has brought together in this volume the results of many years' experience in the teaching and application of metallography in all its branches. The general plan adopted by the author in his treatment of the subject is more like that of a metallurgy of iron and steel written from the standpoint of a metallographist. He does not stop at the boundary of our knowledge of the structure and constitution of metals, but adds considerable interesting information of a more general metallurgical character.

In the first chapter Prof. Sauveur describes the apparatus which he has found most useful in his metallographic laboratory. The subject is taken up in a series of "Lessons," starting first with a description of the physical structure of pure metals, with particular reference to iron; then dealing in turn with the characteristic properties and micro-structure of wrought iron, low-carbon, medium- and high-carbon steels. Under each section are given details as to methods of examination, indicating where changes in properties are accompanied by characteristic differences in structure.

The effect of impurities in iron and steel is next dealt with, pointing out how the microscope may be used to detect their presence in cases where this is possible. The thermo-critical points of iron and steel are described at length in three chapters. A consideration of the annealing, hardening and tempering operations follows, with a chapter on special steels, their constitution, properties, treatment and use, which will be found of considerable value. What may be considered the practical portion of the book concludes with a description of cast iron and malleable iron and the effect of impurities thereon. The work is concluded by a more advanced treatment of the constitution of metallic alloys, the equilibrium diagram and the phase rule, with appendices giving more detail regarding manipulation and apparatus and the nomenclature of microscopic constituents.

A work of such wide scope which, as the author states in the preface, attempts to fill the needs of college students, teachers, those seeking self-instruction, manufacturers and users of iron and steel and the general reader whose interest has been attracted to the subject, and which at the same time takes up advanced discussions which are only of interest at present to the expert, would be most unusual if it fulfilled all these objects with equal satisfaction. The work will probably appeal most strongly to to those who require a guide to self-instruction on this subject; to others it will have considerable value as a work of reference.

Engineers of all classes should familiarize themselves with this branch of metallurgy, and for such the first half of the book may be especially commended. The addition of a chapter on the study of failures in steel, including methods of making a preliminary macroscopic survey of full-sized sections would probably have been welcomed by the testing engineer.

The use of the microscope has become well established as an aid to the examination of metals in nearly every iron and steel laboratory in the United States, it being generally recognized that chemical analysis, physical testing and metallography have each a distinct field of usefulness, each contributing in their way information complementary to the other. Perhaps Prof. Sauveur is ahead of the times in his estimate of the wider practical application of the microscope, but we believe it would be much more to the ultimate advantage of metallography to confine the use of the microscope to its own special field. For instance, the author in Lesson V gives a formula for estimating the strength and ductility of commercial steels based on the relative area of the constituents in iron-carbon steels. In the next chapter, which treats on the effect of impurities, it is pointed out that the ordinary impurities have no decided influence on this structure and may be ignored. Nevertheless, the effect of some of these foreign elements on the tensile strength and elongation of soft and medium carbon steels must be taken into account. So also in claiming equal accuracy for carbon estimations as made under the microscope, on soft and medium carbon steels with those made by the usual colorimetric method, we believe the true field of metallography has been overstepped. The microscope, however, gives valuable information as to the uniformity of the metal which it would be impossible to obtain by any other means.

The reviewer believes, therefore, that it would have been better to more clearly define the practical limitations of metallography, and to warn beginners against expressing opinions on specimens of which they do not have a chemical analysis and which they did not personally polish and etch—such a caution would not be necessary for the practiced operator.

The book is based largely on what appears to be a series of "Lessons" previously prepared and used as instruction papers in metallography. The material contained is of an excellent character and is particularly well illustrated, including many very fine microphotographs of characteristic structures. It is, therefore, all the more to be regretted that the subject matter was not more thoroughly

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edited, and that the usual system of continuous numbering of pages and illustrations was not adopted for convenience in using the index. A good bibliography of standard works on metallography would also have been appreciated. The general character of the work is so good, however, that the author will doubtless find it well worth while to revise some of these details in future editions.

## Two New Books on Mathematics

Reviewed by ARTHUR D. BUTTERFIELD AND RAYMOND K. MORLEY*

DIFFERENTIAL AND INTEGRAL CALCULUS—An Introductory Course for Colleges and Engineering Schools. By Lorrain S. Hurlburt, Collegiate Professor of Mathematics in the Johns Hopkins University. New York and London: Longmans, Green & Co. Cloth; 5½x8½ in.; pp. xviii + 481; illustrated. $2.25, net.

SYLLABUS OF MATHEMATICS—A Symposium Compiled by the Committee on the Teaching of Mathematics to Students of Engineering. Accepted by the Society for the Promotion of Engineering Education at the 19th annual meeting held at Pittsburgh, Penn., June, 1911. Ithaca, N. Y.: The Secretary (Henry H. Norris, Cornell University). Cloth; 5¾x9 in.; pp. 136; illustrated. 75c., net.

Hulburt's Calculus is designed as an elementary textbook, and it belongs to that class of texts, fortunately increasing, that treat, as far as possible, elementary subjects from a good and rigorous mathematical view point.

The treatment is logical and clear. When it has seemed necessary to be less rigorous, for the sake of simplicity in presentation, the omission is carefully noted and is not glossed over.

The work outlining the fundamentals of calculus as given in the first chapters, on introduction, limits and derivatives, is especially good, in fact, one of the best that has appeared. This same high standard is well maintained throughout, for the most part, although it is not so conspicuous where the difficulties are less.

The arrangement of the subject matter departs in some ways from the usual one, not always advantageously. The differentiation of logarithmic and exponential functions is separated from the other rules for differentiation by three chapters of elementary applications. This order, perhaps, adds interest to the first learned rules, but prevents an adequate treatment of logarithmic differentiation, and excludes any logarithmic problems from appearing among the early applications. Partial derivatives are not treated until just before a knowledge of them becomes necessary for multiple integrals. Taylor's and other series, the complete treatment of rational fractions, and envelopes are all delayed until after the work in integral calculus is given, and are placed just before the chapters on differential equations, which conclude the book.

Some matters are included which are often omitted, or only slightly treated in a book of the same scope. The treatment of higher plane curves, especially in parametric representation is excellent. Two good chapters are devoted to Analytic Geometry of three dimensions, a knowledge of which is usually assumed from previous work, an assumption oftentimes not borne out by facts. The line integral for determining the area of cylindrical surfaces is to be especially noted. An excellent treatment of De Moivre's Theorem and of hyperbolic functions is included in the chapter on series.

The author insists on the superiority of the derivative notation over the differential using $D_x$ for $\frac{d}{dx}\left(\ \right)$ in all cases at the start and introduces differentials only as a concession to their almost universal use owing to long custom. This seems to be a much too strong statement of the case. The differential notation offers some unquestionable advantages, especially in exhibiting the relations in which the fractional properties of the increment ratios carry, over into the derivative, in the symmetry of certain total differential forms and in numerous applications in which the notation of the differential as an infinitesimal is extremely helpful.

The author gives a correct and excellent infinitesimal treatment of these cases, but declines to see the advantage of adopting the corresponding notation.

It is somewhat amusing to find that in the chapter on Partial and Total Derivatives, the author devotes a paragraph to calling attention again to the fact that little advantage accrues from the use of the differential, and yet in the same chapter he admits that for certain cases the differential formula is more comprehensive than the derivative, and also shows the geometrical interpretation of the partial and total differential, which admits of much easier representation than do their derivatives.

As in many modern texts, the use of tables of integrals is encouraged, and just about the proper emphasis placed on first being able to integrate many forms without them.

It is unfortunate that in the discussion of indeterminate forms, the author had applied the usual Cauchy's Theorem to what is sometimes called the Generalized Theorem of Mean Value, or the Generalized Law of the Mean. Any student who continues his mathematics into the theory of functions, will find Cauchy's Theorem applied almost universally to the well known propositions concerning integrals around a boundary, and it seems wholly unnecessary to have him confused by any recollection of the same applied to something else.

The exercises in the book are on the whole excellently graded; an increase in the number of problems, however, would be advantageous. For instance, no exercises are given for volumes by triple integration except in connection with center of mass. This lack of problems may seriously affect its use in engineering institutions.

The typographical work is wholly satisfactory. The use of the stroke to denote cancellation in the illustrative problems deserves commendation.

The figures while not always drawn with absolute accuracy are remarkably clear and well planned.

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The syllabus of the mathematics is the result of the work of a committee consisting of 20 members appointed at a joint meeting of mathematicians and engineers, held in Chicago in December, 1907, under the direction of the Chicago section of the American Mathematical Society and Sections A and D of the American Association for the Advancement of Science.

The aim of the work of the committee, as stated in their report, has been to prepare "a synopsis of those fundamental principles and methods of mathematics which, in the opinion of the committee, should constitute the minimum mathematical equipment of the student of engineering."

The syllabus of 136 pp. includes: Elementary Algebra, 13 pp., embracing the general laws governing the fundamental operations, solution of simple equations of the first and second degrees, ratio and proportion, variation and the progression.

Elementary Geometry and Mensuration, 8 pp., embracing the properties of right and oblique triangles, similar figures, plane areas, surface and volumes.

Plane Trigonometry, 17 pp., including fundamental definitions and relations, trigonometric function of acute angles, of angles of any size, solution of right and oblique triangles, the general properties of trigonometric functions, inverse function and trigonometric equations.

Analytic Geometry, 28 pp., including the notation of coördinates, a few fundamental formulas relating to the straight line, a very brief review of facts concerning the circle and the conic sections, transformation of coördinates, general equation of the second degree and coördinates in space.

Differential and Integral Calculus, 43 pp., including functions and their graphical representation, the fundamental formulas for differentiation and their application, integration as the inverse of differentiation and integration considered as the limit of a sum, applications of the differential calculus to expansion in series, to geometry and mechanics.

The book closes with a discussion by different teachers and a brief syllabus on complex quantities. On the whole it is not a textbook, as much of the work

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is suggested, the how of the method rather than the why being given. Its particular province seems to be to afford one who has taken these different subjects, a compact and clear statement of the essentials of the different subjects as commonly demanded in engineering work. In this respect it is admirable and deserves to receive recognition.

It is evident that certain formulas and subjects which many teachers think important have been left out. No one book, however, would emphasize the individual preference. For summarizing the number of essentials which should lie at the basis of an engineer's mathematical training and which in the language of the committee "should be so fixed in the memory of the student that he will never think of looking them up," the committee are to be complimented.

As a book of handy reference for reviewing work, and recalling to mind the important formulas, it should meet with success and be in the library of every engineering student.

## The Unit System of Organization

MODERN ORGANIZATION—An Exposition of the Unit System. By Major Charles DeLano Hine. New York: The Engineering Magazine Co. Cloth; 5x7¾ in.; pp. 110. $2.

We cannot recall when we have found information of greater value between the covers of a small book than is contained in the volume before us. Major Hine calls his book an exposition of the unit system; and the opening chapters of the book are largely devoted to a description of the revolution in organization which has been gradually effected on the Harriman railway lines under his tutelage during the past three years.

The book, however, is very much more than this. It is a keen and critical study of the principles of organization. Every engineer who has any executive responsibility or who ever expects to have will be well repaid by reading and thinking over Major Hine's book.

Under the unit system of organization, as now in force on 27 divisions of the Harriman lines, the titles of the division officers, Master Mechanic, Division Engineer, Trainmaster, Traveling Engineer, and Chief Dispatcher, are abolished. Each of these officers, while performing the same duties as heretofore, is now an Assistant Superintendent. All have their offices in the same building with the Division Superintendent; and the aim is that each of them shall, to a certain extent, share in the executive responsibility of their chief and share moreover in the responsibilities of each other.

As is well known by those familiar with the inner circles of corporation management, one of the greatest obstacles to securing real efficiency in operation is the lack of coöperation between different departments. The mechanical department, for example, has no interest in the road department. The roadway department reciprocates this lack of interest and both join in grumbling at the traffic department. An enormous amount of red tape has been woven with respect to the communication of the different departments with each other. How far this red tape has been eliminated on the Harriman system by the introduction of this new plan of organization may be judged by Mr. Hine's statement that the writing and sending of over half a million letters per year has been eliminated. Without taking space to describe in greater detail the unit system, it may be explained that the term means that the ideal behind it is that the railway company is a single organization and not eight or ten separate organizations, each attending to its own affairs without regard to the others.

The scope of the later chapters of the book is much broader than that of the earlier chapters, devoted especially to the unit system. Some idea of the field covered by these later chapters may be gained from their titles as follows: Chapter IV, Over Specialization; Chapter V, Fallacies of Accounting; Chapter VI, Supplies and Purchases; Chapter VII, Line and Staff; Chapter VIII, Genesis and Revelation of Organization.

Major Hine's chapter on the Fallacies of Accounting ought to serve as a much needed antidote to the present craze for extravagance in cost keeping and auditing. Not that we would deny by any means the usefulness of a proper system of accounting and auditing; but there is a present tendency to give these things an enormously magnified importance and to load up many public enterprises with needless burdens in the way of records and reports.

It is well to stop and reflect occasionally that accounts and records *which are not put to some actual use* are an absolute waste of human energy and a tax upon industry.

It may be well to emphasize the brevity of Major Hine's little book. It is easily read through in an evening. Its value is not measured by the number of words or pages it contains, but by its thought-provoking suggestions.

It has come to this now, that a very large part of human endeavor in civilized lands is carried on through organizations. This applies not only to the whole range of industrial work, but to all our government operations, national, state and municipal, and to the multitude of social organizations, clubs, labor unions, political and religious bodies.

There will doubtless be those who will criticize many of the positions which the author of this book takes, but all will agree that his proposals and recommendations are well worth careful study.

## Tropical Water Bacteriology

Reviewed by C.-E. A. WINSLOW*

THE BACTERIOLOGY OF SURFACE WATERS IN THE TROPICS — By Wm. Wesley Clemesha, M.D. (Vict.), D. P. H., Major, Indian Medical Service; Sanitary Commissioner, Bengal; Professor of Hygiene, Medical College, Calcutta; Late Officiating Sanitary Commissioner, Madras. Calcutta; Thacker, Spink & Co. London: E. & F. N. Spon. Ltd. Cloth; 5½x8¾ in.; pp. 161; numerous tables. Rs. ⅞.

Major Clemesha, of the Indian Medical Service, is known to sanitary engineers for his valuable book on "Sewage Disposal in the Tropics." Like this earlier work the present volume is suggestive and important, because it throws the light of experience, under widely different conditions, upon some of our common problems.

Water supplies in India are for the most part derived either from ponds or large tanks or from vast sluggish rivers. In either case the initial pollution is likely to be great, but the storage is usually considerably in excess of that available in temperate climates. The problems of self-purification thus assume peculiar importance and Major Clemesha has made on important contribution to them in this careful study of particular types of fecal bacteria and of their behavior in water.

He finds from an examination of a large series of samples of human feces and cow dung that, as in temperate climates, the lactose fermenting colon-like bacilli and the lactose fermenting streptococci are the predominant forms. Absolute numbers of human intestinal bacteria are much lower in England than in India, however, probably on account of the vegetable diet. In particular the fermentative reactions of the streptococci are significant, for, just as in Houston's work in England, the predominant type in cow feces was found to ferment lactose, saccharose, salicin and raffinose, while raffinose fermenters are rare in human feces.

Important light is thrown upon the viability of various intestinal bacteria in water, by the relative abundance of a large series of forms in stored waters from tanks and reservoirs. Major Clemesha has accumulated a mass of information of this sort and checked it up by numerous bottle experiments in the laboratory. He finds, as Houston did, that the lactose-fermenting streptococci die out in water very rapidly and may therefore serve as an index of fresh and recent pollution. On the other hand the bacilli which produce acid and gas in dextrose media, but not in lactose media, multiply extensively in water. Such forms make up only 5% of dextrose fermenting bacilli in feces, but in stored waters, particularly in hot weather, they

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may constitute over 50%, and in bottle experiments may rise to 95% of all fermenting organisms. The same thing has been shown in England by Houston and in the United States by Phelps and the reviewer, who found between 80 and 90% of a series of unpolluted waters at Ann Arbor, Mich., Exeter, N. H., and Bar Harbor, Me., containing dextrose fermenters in one cubic centimeter samples in summer weather.

The particularly novel observations of Clemesha concern the relative viability of members of the colon group, as ordinarily defined by American and English water bacteriologists. The typical B.coli, fermenting dextrose, lactose and dulcite, but not saccharose, perishes rather rapidly and furnishes a good index of pollution. and B.acidi-lactice (dextrose and lactose positive, dulcite and saccharose negative) and B.aerogenes (dextrose, lactose and saccharose positive, dulcite negative), occupy a somewhat intermediate position, sometimes multiplying for a time, but not persisting long. B.cloacæ, which differs from B.coli, principally in not fermenting dulcite and in liquefying gelatin, is one of the most resistant types. It sometimes survives all other fecal forms in bottle experiments and is very common in tanks and rivers in hot weather. A still more serious problem is presented by what the author calls the B.Grunthal or B.vesiculosus type which differs from B.coli only in failing to attack dulcite and which would be included as a colon form in all routine work in this country and in England. This organism is highly resistant and is common in tanks and reservoirs in hot weather.

The moral drawn by Major Clemesha is that, for Indian conditions, with much initial pollution and much storage, it is not proper to condemn water containing any members of the colon group without distinguishing between the more and the less resistant forms. For example, he quotes 239 examinations, of which 74 showed no B.coli according to the English standard, which closely corresponds to our own, while 165 showed what we should call positive results. Of the 165, however, 128 were forms of the B.acidi-lactici, B.vesiculosus and other types, not fermenting dulcite, and classed by the author as highly resistant and not indicative of recent pollution.

Major Clemesha does not claim that these results necessarily indicate any change of procedure in dealing with the waters of temperate climates. Indeed the experience of English and American bacteriologists offers pretty conclusive evidence that waters so stored as to be safe do not in this climate contain large numbers of lactose fermenting organisms of any type. In other tropical countries, and perhaps in warm summer weather here, the Indian conditions may perhaps be duplicated (as we know they are in the case of the forms fermenting dextrose but not lactose); and the experiments reported in this book deserve the study and careful consideration of water bacteriologists and sanitarians.

## A Teacher's Discussion of the Electric Circuit

THE ELECTRIC CIRCUIT—By V. Karapetoff. Second Edition, rewritten, enlarged and entirely reset. New York and London: McGraw-Hill Book Co. Cloth; 6x9½ in.; pp. 229; 55 text figures. $2, net.

This book is the outgrowth of the author's earlier pamphlet, bearing the same title, which was presumably a tentative arrangement made primarily for his own classes and not widely circulated. The present work stands more complete in itself as a discussion of the fundamental actions in an electric circuit with either steady or alternating current flowing; there are also some studies into the actions in practical circuits of certain everyday equipments. The volume appears as a companion work of the author's "Magnetic Circuit" (reviewed in ENGINEERING NEWS, Feb. 15, 1912) and, together with that, forms a complete elementary (but not rudimentary) treatise on the theoretical elements of electricity and magnetism.

The book in hand presents its topics in an orderly sequence, which should give a safe scheme for traveling along a road of increasing difficulty; but this volume does not contain the iconoclastic novelties that were noted in "The Magnetic Circuit." It also less evidently considers the designer's standpoint, although the same scheme of procedure (principles expounded, formulas developed, and results applied to commercial apparatus) is to be seen.

To one familiar with the actions discussed and the principles outlined, the author's treatment seems so lucid and his problems (appended to each section) so interlinked with common experiences that the book may be regarded by some as a self-teaching text, needing no classroom or instructor in the flesh. That doubtless would be an over-optomistic judgment of the value of the work, but it would show the author's success in developing an easily read and well connected textbook.

Direct-current (steady current) relations are first taken up with sub-topics like resistance, temperature effects, networks, current densities, voltage gradients, irregular paths, etc. Alternating-current phenomena are led up to through a study of all the instantaneous potentials involved, and this reduces, of course, to an application of the preceding direct-current discussion for infinitesimal times. Vector diagrams, which play such an important role in alternating-current discussions, are early presented to give the students facility in the study of voltages and currents which are combined in practice, though not in time-phase with each other. The allied subject of complex quantities are presented in general after the fashion of Steinmetz, but the author's explanation of the use of the symbol $j$ (to indicate geometrical additions of two vectors at right angles, or of 90° rotation of a vector, and finally giving this symbol an imaginary value $\sqrt{-1}$, seems somewhat more direct and more easily grasped than the explanations which have been presented in many American class-rooms. This topic of complex quantities follows a discussion of the alternating-current analogues of resistance to direct current—inductance, reactance, and impedence. This completes the pure theory, except for a later chapter interjected on the "dielectric circuit"—meaning an arrangement of bodies under what has up to now been commonly described as "electrostatic action"—involving capacity for receiving charges, dielectric stresses, insulation values, etc.

Following the theoretical discussions are studies of a few lines of everyday equipment—studies of current and voltage relations, regulations, etc., of overhead transmission lines, transformers, induction motors, and sheathed cables.

BOILER DRAUGHT—By H. Keay Pratt, M. I. Mech. E. New York: D. Van Nostrand Co. Cloth; 5x7½ in.; pp. 138. 29 text figures. $1.25, net.

This book is another one of those published in the first place for British readers, but drawn across the Atlantic for reasons which are not obvious. American readers who seek for a discussion of boiler-room practice that is widely applicable to American conditions will be disappointed. We would not like to say that it does not correctly reflect operating practice on the other side, but at the same time we must remark that if the book is an accurate index of that, then the art is not advanced as far as we had reason to believe. For instance, the author gives no hint of the ability to increase boiler capacity 100 to 300% by heavier fuel beds and increased draft. The author states that the book was prepared particularly for operating attendants; that probably explains the obvious dilution of the instruction.

Early in the work there is a discussion of development of air pressure; here in describing a draft gage to be used in determining the draft pressure (above or below atmosphere) in a boiler setting, the author states that the exploring tube, connected to one arm of the U-gage, should be bent up at right angles and should be presented so that the inlet faces the stream of gases. Now, if the existing pressure was desired, and not pressure plus or minus velocity effect, then the inlet should be at right angles to the stream of gases, whether forced or induced draft was employed. If induced

draft, such as is secured from an ordinary chimney, should be measured in the way the author indicates, the actual draft would be more than that shown by the gage reading. After showing calculations for the flow of air, the author presents various empirical relations between size of chimney and amount of boiler capacity, and then briefly considers chimney construction.

The sections on forced and induced draft are largely given over to computations of the best dimensions of fans. So long as American manufacturers have published quite complete data on the performance, capacity and dimensions of draft apparatus, it would not seem as though it was necessary in this country for a plant operator or designer to go to the trouble also of designing the fans.

There is a chapter on the application of mechanical draft for stationary installation, but in this some of the most important forms of boiler setting seen in this country are not mentioned. We can hardly believe that the author has included all the important British installations either. The book closes with a discussion of the use of mechanical draft on board ship and a chapter on the chemistry of combustion.

PRELIMINARY STUDIES IN BRIDGE DESIGN—Being the first of a series of small volumes, each complete in itself, dealing with the design of ordinary highway bridges of moderate spans. By Reginald Ryves, Assoc. M. Inst. C. E., M. Assoc. Cons. Engrs.; Author of "The King's Highway, or the Nature, Purpose and Development of Roads and Road Systems." London: The St. Bride's Press, Ltd. Cloth; 5x7¼ in.; pp. viii + 57; 33 text figures. 2/-net, 80c.

This little book, a reprint of articles which appeared in *The Surveyor and Municipal and County Engineer,* is intended as the first of a series of similar volumes which, taken together, will form a treatise on the design of ordinary highway bridges of moderate spans. This first volume goes further back in the evolution of the bridge than do most treatises and considers the bridge in its essential elements, that is as the means of providing a crossing for man and beast across a watercourse. The bridge engineer is apt to forget this primary purpose and to consider his bridge merely as a framework or a carrier of stresses. Mr. Ryves, in a refreshingly original manner, has emphasized the necessity for studying natural and economic predispositions, one might say, of the bridge site, with a view toward producing, not the best type of bridge, but the best method of getting the river and the traffic across one another. Such a study naturally develops descriptions of a number of structures, such as fords, inverted siphons, road dams, etc., which the engineer is apt to forget in his design of small highway bridges. Furthermore it demands a treatment of the requirements of bridge location and the peculiarities of stream regimen.

The book is a small one, so the discussion is necessarily limited. On the whole its purpose is to provoke thought rather than to state invariable principles or present typical designs.

## Bridge Aesthetics

ARTISTIC BRIDGE DESIGN—A Systematic Treatise on the Design of Modern Bridges According to Aesthetic Principles. By Henry Grattan Tyrrell, C. E.; Author of "Mill Building Construction"; "Concrete Bridges and Culverts"; "History of Bridge Engineering"; "Mill Buildings." With an Introduction by Thomas Hastings, of Carrere & Hastings, Architects. Chicago: The Myron C. Clark Publishing Co. Cloth; 6x9 in.; pp. xvi + 294; 150 illustrations. $3, net.

In spite of the difficulties of defining the beautiful in art, there will be few to deny the essential ugliness of the average bridge structure. To attempt to formulate the principles that underlie artistic bridge design is another matter. Anyone can say that a bridge is hideous. To explain why it is hideous to the satisfaction of one not versed in the verbal juggling common to most writers on art and architecture is a formidable task. Such is the task Mr. Tyrrell had set for himself, and on the whole has performed acceptably.

The book is prefaced with a general plea for coöperation between architects and engineers in bridge design, written by Thomas Hastings, the well known New York architect, and by several obvious chapters by the author on the importance of bridges and the necessity for their artistic treatment. The meat of the book starts with Chap. III, which is entitled "Standards of Art in Bridges." The author states that bridges are considered beautiful when they fulfill the following requirements: (1) Conformity with environment; (2) economic use of material; (3) exhibition of purpose and construction; (4) pleasing outlines and proportions, and (5) appropriate but limited use of ornament. He then proceeds to develop these five propositions. Chap. IV is on the causes for the lack of art in bridge design, particularly in America. Ten reasons are given, principal among which is the lack of artistic ability in engineers and with its consequent evils and the restrictions brought about from considerations of economy. The next chapters take up the principles of design, which the author states to be (1) the selection of the most artistic form consistent with economy, (2) expressiveness, (3) symmetry, (4) simplicity, (5) harmony and contrast, (6) conformity with environment, (7) proper accommodation of materials, and (8) a judicious use of applied ornaments. The remaining chapters are devoted to the specific types of bridges; ordinary steel structures, cantilever bridges, metal arches, suspension bridges, and masonry bridges being taken up in turn. The remainder of the book, about 150 pages, is given over to full-page illustrations of various handsome bridge structures throughout the world with short descriptions accompanying each photograph. The book is profusely illustrated throughout with drawings and photographs of typical bridges and with details such as railings, piers, etc., illustrating certain points set forth in the design. Unfortunately, as in at least one other of the author's books reviewed in these columns, the figures are not denoted by captions, so that it takes some searching through the text to discover what each one is intended to illustrate.

The day has come when the engineer does not regard it as unmanly to consider beauty as well as strength in his design. On the other hand, the architect is coming to realize that structural necessities are as important as beauty of line and form. The coming together of these two great professions will surely benefit the artistic design of bridges. Just how much can be done by categorical statements of what is beautiful and what is ugly, we would not attempt to state, but we feel sure that any engineer who reads such books as this one of Mr. Tyrrell's and at the same time conscientiously studies the photographs and drawings of beautiful designs which Mr. Tyrrell gives and which can be found elsewhere will arrive at a better appreciation of what lines and form an artistic bridge should have.

SOME FACTS ABOUT TREATING RAILWAY TIES—By W. F. Goltra; President, the W. F. Goltra Tie Co., Cleveland, Ohio. Paper; 6x9 in.; pp. 105; 8 folding plates. $1.

This is mainly a compilation of papers read before technical societies and articles published in the technical press, with discussions upon them. There is also a discussion of the claims of the so called empty-cell process of treatment with creosote, in which a proportion of the oil injected is withdrawn from the wood. Some of the points advocated by Mr. Goltra are as follows: 1, ties should be seasoned (preferably by artificial means) before treatment; 2, ties should be treated to total refusal, and not by any process which seeks to withdraw a portion of the preservative after injection; 3, zinc-chloride alone and in combination with creosote is more economical than creosote alone in treating ties to refusal; 4, it is useless and impracticable to group ties for treatment according to their species, degree of seasoning, proportions of heart and sap wood, etc.

A bulletin of the U. S. Bureau of Mines, entitled "Magazines and Storehouses for Explosives," discusses first the precaution necessary in the construction and reconstruction of maga-

zines for the storage of explosives and then gives in detail the design of several typical explosives magazines which are recommended by the Bureau. Particular attention has been paid to the ventilation and drainage of the magazine, to the production of a bullet-proof wall and to the question of thawing explosives.

## Caisson Sickness

Reviewed by H. JAPP*

CAISSON SICKNESS AND THE PHYSIOLOGY OF WORK IN COMPRESSED AIR—By Leonard Hill, M. B., F. R. S.; Lecturer on Physiology, London Hospital. London: Edward Arnold. New York: Longmans, Green & Co. Cloth; 5½x9 in.; pp. ix + 255; 66 text figures. $3, net.

Dr. Leonard Hill is especially fitted for writing on this subject as he has made a most scientific investigation of it, and shows considerable sense of humor in relating anecdotes in connection with compressed-air work.

He disposes of the old theory of caisson sickness held by Dr. Smith of Brooklyn Bridge fame, and concludes that Paul Bert's air embolism theory, as outlined in 1878, is the only one that can be accepted, and proves it by placing a frog so that the web might be illuminated with an arc light and projected microscopically on to a screen. Even 20 atmospheres had no effect on the circulation, but on suddenly decompressing, bubbles appeared in the capillaries, growing in size and number until they stopped the circulation. On reapplying the pressure the bubbles shrank and disappeared and the circulation was resumed.

Dr. Hill asserts that carbon dioxide has no effect on caisson disease, and considers the supply of 8000 cu.ft. of free air per man-hour on the East River Tunnels a serious waste, evidently not being aware that the air was necessary to make up the loss through the porous nature of the ground. His experiments showing that fat absorbs five times as much nitrogen as blood is very suggestive to corpulent air workers.

Haldane's theory of stage decompression is dealt with, by which workers in +40 lb. reduce the airlock pressure in 3 min. to +12½ lb., which gives the imprisoned nitrogen in the body a difference of 27½ lb. to force its desaturation. The subsequent decompression continues at such a rate that the maximum saturation of the body is never more than double the pressure in the airlock, or atmosphere. Under this system men have dived in 210 ft. of salt water safely, or the equivalent of +92.4 lb.

Dr. Hill, in criticizing Dr. Haldane's method, finds by experiments on animals, no less a number of accidents by the stage method than by the uniform decompression method, if both done rapidly. Inasmuch as he uses a time admittedly too short to be safe, one would conclude that Dr. Hill has not made out his case, as he admits that stage decompression is the right method to adopt.

Mention is made of the application of Haldane's stage method as modified on the East River Tunnels by Japp, where about 24,000 individual decompressions took place without mishap from 40 lb. gage pressure. Here Haldane's times were reduced to half, and Dr. Hill goes on to say that if very active exercise is carried out during decompression even Japp's table could be reduced to one-third of the proposed times. He quotes Bornstein as having calculated that the same volume of nitrogen expelled by uniform decompression in 1 min. would be expelled by stage decompression in half a minute; by breathing oxygen in 0.35 min.; by forced breathing during decompression in 0.5 to 0.9 min.; with light bodily work in 0.2 to 0.35 min.; heavy bodily work in 0.1 to 0.2 min. Anything which will increase the circulation of the blood during decompression will facilitate the liberation of nitrogen and reduce the risk of caisson disease.

With regard to the cure of caisson sickness, great credit is given to Moir for instituting the first medical airlock.

In conclusion, Dr. Hill states that engineers might carry out, without excessive risk to life, works at depths which they do not now attempt, and he confidently looks forward to some important work at a pressure of +60 lb. by a carefully picked and trained body of young men.

The collection of Dr. Hill's researches and the bringing up to date of world wide data on this important subject makes engineers and doctors doubly indebted to Dr. Hill.

*S. Pearson & Son, Inc., 507 Fifth Ave., New York City.

## Scientific Management

APPLIED METHODS OF SCIENTIFIC MANAGEMENT — By Frederick A. Parkhurst, M. E., Organizing Engineer; Assoc. A. S. M. E. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. 325; 9 folding plates and 48 text figures. $2, net (8/6, net).

So much has been said about "efficiency engineering," or pseudo "scientific management," in a general way that students of such developments may well expect now to secure a knowledge of general procedure without waiting for more books to be written—though doubtless these will come along more or less regularly.

No matter how well "principles" have been expounded, as such, still descriptions of experiments in special fields and applications to various concerns will be useful. Therefore the book before us should be kindly received by all interested in the new administration, as it gives an unusually complete record of the reorganization of an existing machine works. There is comparatively little here that is directly didactic or argumentative; the presentation is more a description of concrete methods—schemes adapted to the local needs.

The Ferracute Machine Co., of Bridgeton, N. J., is the company whose operations are thus disclosed. The author first takes up the preliminary investigation and the formation of a new scheme of organization. The functions of the new sales, accounting, engineering, drafting and planning departments are summarized and the duties of various officials outlined—persons like the superintendent, shop engineer, inspector, the moving, speed and material bosses, and the production, stores, cost, route, order-of-work, shipping, receiving, time, and schedule clerks, etc. The permanent "organization record," a volume containing exact instructions for each responsible person in the plant, is largely reprinted as an appendix (nearly a third of the volume). The rest of the book, briefly, is an amplification of the foregoing relative to routing plans, moving jobs, work of subforemen, stores and inventory, standard practice with standard tools, time study, wage rates, extra payments, etc.

## Railway Addresses

THE RAILWAY LIBRARY, 1911—A Collection of Noteworthy Addresses and Papers Mostly Delivered or Published During the Year Named. Compiled and edited by Slason Thompson, Director of Bureau of Railway News and Statistics of Chicago, Ill. Third Series. Chicago: Bureau of Railway News and Statistics, Railway Exchange Building. Cloth; 5½x8¾ in.; pp. 46. 50c.

Mr. Slason Thompson, the railway statistician, has done a public service in compiling this volume. It contains some of the most notable papers and addresses which have appeared in the past year relating to the broader questions in connection with railways and their public relations. The leading place is given to the first report of the Interstate Commerce Commission, made in 1887. The nation owes a great debt to Judge Thomas M. Cooley, the first Chairman of the Commission, for the work which he did in the organization of the Commission and in laying down the broad lines on which it should be conducted. Mr. Thompson well says in his introduction:

> For judicial equipoise and statesmanlike appreciation of the necessities and difficulties involved in federal regulation of railways, this report stands unsurpassed in the literature of railways. It is as authoritative today as when written.

Among the other notable papers printed in this volume are addresses by Chief Justice Knapp, of the Court of Commerce, Charles A. Prouty and Franklin K. Lane, of the Interstate Commerce Commission, the report of the Hadley Commission on Railway Securities, Prof. Geo. F. Swain's report on the Valuation of the New York, New Haven

& Hartford R.R., addresses on Efficiency of Railway Service, by Julius Kruttschmitt, General Manager of the Harriman System, and by Warren F. Stone, Chief of the Brotherhood of Locomotive Engineers, a digest of the legislation enacted in 1911 affecting railways, and the report of the Federal Board on Block Signals and Automatic Control.

The last quarter of the volume contains statistics of American railways for 1911, compiled by Mr. Thompson. The very low price at which the book is issued and the number of valuable papers which it contains should secure for it a wide circulation.

## A Complete Resume of the Government Tests of Structural Timbers

TESTS OF STRUCTURAL TIMBERS—By McGarvey Cline, Director, Forest Products Laboratory, and A. L. Heim, Engineer in Forest Products. Bulletin 108, Forest Service, U. S. Department of Agriculture; Henry S. Graves, Forester. Washington, D. C.: Pub. Doc. Paper; 6x9¾ in.; pp. 123; 29 text figures; 15 tables; one folding map.

Since 1903 the U. S. Forest Service has been conducting in its different laboratories tests on the various strength factors of the structural timbers used in the United States. Prior to the establishment of the Forest Products Laboratory, in cooperation with the University of Wisconsin in 1909, tests were carried on in laboratories conducted in coöperation with Purdue University, Yale Forest School, University of Oregon, University of California, University of Washington, and the University of Colorado. Since 1909 coöperation with all these laboratories, except those of the University of Washington and the University of Colorado, has been discontinued and the timber-test work centralized in the Forest Products Laboratory in Madison, Wis.

As may be readily understood, a large number of data have been collected in the past nine years in this work and from time to time reports and bulletins have been issued which covered different portions of the study, but never until the present has a complete résumé of the investigations of the structural timber tests been made by the government service. As the investigations in the different laboratories were well correlated and the methods of testing thoroughly studied, the results are by far the best information we have today upon the strength qualities of timber. As the bulletin well says, the results here published should be of use (1) in determining working stresses and proper factors of safety in connection with the design of timber structures, (2) studying the relation of the physical characteristics and defects of timber to its strength and other mechanical properties, and (3) in devising standard specifications and grading rules for timber and structural timbers, along which line much valuable work has already been done by the American Society for Testing Materials, and the American Railway Engineering Association.

The materials tested cover practically all of the structural timbers in use in the United States, including the different pines of the Southern States, the firs, hemlocks and redwoods of the Pacific Coast and the hard pines, spruces and tamaracks of the New England and Lake States. The tests comprised bending tests on stringers and heavy joints, light building joists and small clear beams, compression parallel to grain, compression perpendicular to grain and shearing tests on small pieces, investigations of the moisture content and rate of seasoning, the relation of mechanical to physical properties, such as the color of the wood, the relative proportion of hard wood, sapwood, the condition of the pith, rate of growth, the weight and the proportion of summer wood.

With the figures obtained from the investigations as a basis, the Service has also studied the grading of timber beams according to their mechanical properties and has outlined a method of separating the different kinds of wood so as to throw them into the proper commercial grade. The preface states that no attempt has been made to recommend the factors of safety which should be applied to the values given in the table, but a complete analysis of the variation of individual results is presented and the matter left to the judgment of engineers. The aim has been to make the text of the bulletin serve as a guide to the study of the diagrams and tables rather than as an exhaustive treatise on the subjects taken up. This brevity has permitted the use of more complete diagrams and tables than has been possible in previous publications of the Forest Service dealing with timber tests. The appendix contains complete descriptions and test data of the timbers tested, covering a space of some 55 pages.

No small part of the work of the Service is the emphasis laid upon the variation of commercial timber, and the difference in the properties of small size and large size pieces. The bulletin contains a number of diagrams, which show conclusively that average unit strength values, computed from a number of tests, vary considerably from the extremes of the tests, and that, in consequence, a large percentage of commercial wood will have a very small safety factor if designed according to generally accepted unit strength values, which are based on averages. This fact, together with the exposition of the superior strength of small size test pieces has been well hammered into the engineering public by the Forest Service tests and the present résumé adds to the importance of their work.

A MANUAL OF INSTRUCTION IN THE PRINCIPLES OF PROMPT AID TO THE INJURED—Including a chapter on Hygiene and Disinfection. Designed for civil and military use. By Alvah H. Doty, M. D., Late Health Officer of the Port of New York; Late Major and Surgeon, Ninth Regiment, N. G. N. Y. Fifth edition. New York and London: D. Appleton & Co. Cloth; 4¼x7¼ in.; pp. xv—229; 85 text figures. $1.50, net; postpaid, $1.62.

By the use of small but readable type and general compactness of manufacture as well as of subject matter, Dr. Doty presents in a handy volume much more information than is given in many of the other accident or emergency manuals. In fact, he devotes a number of chapters to a description of the human body and its mechanism before taking up emergency measures. The latter, too, are set forth with considerable explanatory detail. The book, therefore, lends itself to careful study by those who lack medical training but yet may be called upon to aid a person with a serious burn, a broken bone, a severed artery, a snake bite; or who has been prostrated by heat, subjected to frost or subjected to risk of drowning. Unusual to such books, is a chapter in this one on Hygiene. The paragraphs on water purification might well be more explicit and in the revision a few lines on the disinfecting value of hypochlorite of lime or of soda might have been added.

HISTORICAL PAPERS ON MODERN EXPLOSIVES—By Geo. W. MacDonald, M. Sc. (Melb.); Head of Research, Messrs. Curtis's & Harvey, Ltd. With an Introduction by Sir Andrew Noble, Bart., K.C.B., F.R.S. London and New York: Whittaker & Co. Cloth; 6¼x10¼ in.; pp. 192. $2.50, net.

The compiler of this volume has drawn into one volume the most important historical papers relating to the development of modern explosives. They have been taken, in somewhat revised form in many cases, from various society proceedings, publications, etc. The list is long and begins with the discoveries of fulminate of mercury (1800), nitrostarch (1833), and guncotton (1846). The history of guncotton is pursued by papers detailing progress in France, Scotland and England, and describing the work of Schönbein, Tonkin, Abel, Berzelius and Hall. After papers on guncotton manufacture in Austria and England, comes a string of ten communications from Sir Frederick Abel on guncotton. After this are given the work of Arcanio Sobrero, discoverer of nitroglycerin, and the patents of Alfred Nobel for the manufacture of nitroglycerin, dynamite, blasting gelatine, gelignite and ballistite. The book closes with papers on the decomposition of nitroglycerin.

The first magazine devoted exclusively to wireless telegraphy has now appeared bearing the name *The Marconigraph*. This first issue has a sketch of the life

of Guglielmo Marconi and a number of articles on training Marconi operators, the use of wireless apparatus in the army, equipment for vessels, etc. There are departments devoted to amateur activities, notes and queries, patents, etc.

The magazine seems to have some friendly coöperation with the Marconi interests, but no direct connection is disclosed.

## Laboratory Work in Physics

A MANUAL OF PHYSICAL MEASUREMENTS—By Anthony Zeleny, Ph. D., Professor of Physics, and Henry A. Erickson, Ph. D., Assistant Professor of Physics, University of Minnesota. Third edition. New York and London: McGraw-Hill Book Co. Cloth; 5x7¾ in.; pp. 248; 125 text figures. $1.50, net.

The evident aim of the authors of this book, in planning experiments to be performed in the laboratory by college students under the guidance of an instructor, has been explicitness. They have described apparatus at length, have given suggestions as to the use of it and have added precautions which must be taken to get the results which mature experience shows that the students ought to get.

In fact, if there is any criticism to be made against this manual, it is that it is too explicit. On that score it probably will not be generally regarded as being in line with the most modern thought on the teaching of elementary physics. The book very evidently has been prepared for those who believe in the orthodox method developed in years past—that of telling the student in the lecture room what is so and sending him into the laboratory to demonstrate it. The criticism which is being directed against this method of teaching physics is that it does not give a sufficiently transferable discipline to the student; that it presents to him no branch-road situation where he must plan, observe and deduce from observations to find what will happen under certain conditions. Many good engineers still recall their disgust, as students, for some of the laboratory experiments which were planned for them, being willing to accept the principles expounded in lecture without going through the prescribed work which was supposed to demonstrate the idea and which usually did so after sufficient juggling to eliminate the effects of inexperience and clumsiness.

This book now appears in its third edition, which would indicate that it had met with appreciation on the part of college teachers of physics. Perhaps the reason for this success lies in the very explicitness which we have already noted. A manual like this ought to enable an instructor to give his courses with a minimum of thought and effort. As an idea of the explicitness with which the authors have carried the planning of an experiment it is only necessary to note that a bright student with a good imagination, taking lectures in physics, would be able to follow this manual and write up in advance the results of very many of the experiments without even going into the laboratory.

The manual opens with familiar experiments in mechanics—measuring the volume of a cylinder, determining the radius of curvature of a spherical surface, and finding the mass of a body. Then there are demonstrations of Hooke's law with flexible beams, stretched wires, twisted wires, etc. There are experiments to test equations for moments of inertia, parallelograms of forces, relations of force and angular velocity, etc. The falling acceleration due to gravity is approached through the use of a simple pendulum.

There is a very short section on fluids with experiments for verifying Boyle's law and for finding the specific gravity of solids and liquids. There are also short sections on light, heat and sound. The work in heat includes experiments on atmospheric pressure, calibration of thermometers, demonstration of Charles' law, radiating power of different surfaces, determination of specific heat, latent heats of fusion and vaporization, vapor pressure of water, humidity of the atmosphere, mechanical equivalent of heat, etc. Under sound are found experiments on the velocity of transverse waves, the velocity of sound in air and solids, the frequency of tuning-fork vibrations, etc. Under light are studies with spherical mirrors and lenses, determinations of magnifying power of optical instruments, the use of the spectrometer, finding the wave lengths of light and the characteristics of polarized light.

The section on electricity and magnetism occupies over 50% of the book. The material given in the sections other than for electricity and magnetism may be truly called elementary. But that in these allied subjects is of a much more advanced nature, some of the work being that which is given in most technical schools only as the senior year is approached. Thus while the section opens up with the manipulation of the gold leaf electroscope and the plotting of a magnetic field by needle exploration, it rapidly rises into the details of properly using magnetometers, determining the constants of the earth's magnetic field, calibrating an ammeter by means of a tangent galvanometer, finding the correction factors of an ammeter by the silver-voltameter method, and finding the relation between current and deflection of a moving-coil galvanometer. The potentiometer method of measuring the e.m.f. of a battery, and the calibration of voltmeters, ammeters, etc., are taken up. Now the potentiometer is a refined instrument which is not usually placed in a student's hands until he has well passed the more elementary electrical laboratory work. The theory of the ballistic galvanometer is given in a few pages and followed by other advanced topics like the calculation of coefficients of self-induction, determination of the coefficient of self-induction by Maxwell's and Anderson's methods, a study of the magnetic properties of iron, etc.

SMOKE—A Study of Town Air. By Julius B. Cohen, Ph. D., B. Sc., F. I. C., S.; Professor of Organic Chemistry in the University of Leeds, and Arthur G. Ruston, B. A., B. Sc., Scientific Tutor in the Department of Agriculture, University of Leeds, New York: Longmans, Green & Co., London: Edward Arnold. Cloth; 5½x9 in.; pp. 88; 35 text figures, $1.40, net.

British studies of the effect of smoke upon the composition of the atmosphere of cities and upon the effect of smoke-charged atmospheres on vegetation and on stone and mortar are here presented in readable form. So many of the analyses cited are from one to three or more decades old as to make one wonder whether the many would-be smoke abaters of England and Scotland during the past five or ten years have given up making and reporting analyses. Wisely, it seems to us, the authors do not attempt to show what the relationship is between smoke-laden air and the health of human beings. They do insert an appendix presenting statistics designed to prove that smoke is inimical to health, but the same figures, or many of them, might be used with equal force to prove various other assumptions. The authors certainly did well in relegating such figures to an appendix.

FRESH AIR AND HOW TO USE IT—By Thomas Spees Carrington, M. D., Assistant Secretary of the National Association for the Study and Prevention of Tuberculosis; Author of "Tuberculosis Hospital and Sanatorium Construction." New York: The Association (105 E. 22d St.). Cloth; 5¼x8 in.; pp. 250; 150 text figures. $1, net.

For a popular book, designed both to encourage everyone to stay outdoors even when indoors and to show them just how to do it, this volume should be eminently successful and thus do a world of good. An almost endless variety of ways of tacking outdoor sleeping rooms and living rooms onto houses and other buildings is presented, so one only has to keep looking and he will be almost sure to find how some other seeker of fresh air has found it under conditions similar to his own. We are pleased to see that the author does not lose sight of the fact that it is possible to add a fresh-air room to an old house and always possible to provide one in a new house without sinning against all the canons of architecture and good taste. Finally, the book would have been more useful had the author provided a few more line drawings—even had it been necessary to sacrifice a dozen or two of the many halftones.

The office of Public Roads of the U. S. Department of Agriculture has issued as Bulletin No. 46 a pamphlet by the Di-

rector, Logan W. Page, entitled "Oil-Mixed Portland Cement Concrete," which presents in somewhat more detail the results of the same investigations that Mr. Page reported two years ago before the American Society of Civil Engineers. The tables are the same as then given with the addition of later tests made possible by the lapse of time.

## Building the Panama Canal

THE AMERICANS IN PANAMA—By William R. Scott. New York: The Statler Publishing Co. Cloth; 5x8 in.; pp. xiii + 258; numerous illustrations and maps. $1.35, net. $1.47, postpaid.

To the reader desiring a popular account of the work of building the Panama Canal, we are inclined to rate this book as the best that has so far appeared. Perhaps the most difficult task of the writer who attempts to tell the story of the Panama Canal is to know what to put in and what to leave out. The enterprise possesses so many aspects of interest that there is constant temptation to devote undue space to that aspect which appeals most to the writer who has the task in hand.

The author of the present volume has given his chief attention to the work done upon the canal's construction since the Americans took possession, and, as he says in his preface, he has given only so much of the history of the Isthmus under the Spanish and during the construction of the Panama R.R. and the first attempt to dig the canal under the French, as was necessary to lend a perspective to the work of the Americans.

The author has succeeded well, also, in his attempt to record the important events rather than mere instances in connection with the progress of the work.

The author spent five months in Panama, and for three months of the time was an employee of the Isthmian Canal Commission. Concerning the engineering work on the canal, the author gives only the principal facts, and steers clear of technicalities and details, as is entirely proper in a book written for the general reader. He brings out with strong emphasis the wisdom of the decision to build the canal with locks instead of at sea level, and gives well deserved credit to President Roosevelt for making the final decision that the canal should be of the lock type. We quote as follows:

> To reject the majority report of the International Commission favoring a sea level canal and to advocate the minority report for a lock type canal, was a responsibility of unusual magnitude for an Executive who professed to have no technical engineering knowledge. Yet, President Roosevelt made the momentous decision without hesitation, sending a strong message recommending the minority report. It was perhaps the greatest crisis in the history of the project, and the American people have to thank his sound judgment in preventing a sea level experiment, that undoubtedly, in the light of recent years, would have exhausted the patience and maybe the finances of the nation.

Probably the feature of the book which will excite the greatest interest is the author's discussion of the part taken by the United States in the revolution in which Panama declared its independence of Colombia. The author goes into this subject in considerable detail and defends the action of President Roosevelt as justifiable under the circumstances. On the other hand, he holds that the United States has a moral obligation to Colombia by reason of the loss that country suffered of her richest province, for which we were in a measure responsible. In a separate chapter, entitled "Settling our Account with Colombia," the author urges that we should make reparation to Colombia for our action in connection with the Panama revolt. The plan which he proposes is that the United States should restore Panama to Colombia, reserving the Canal Zone and retaining the same right of control and sovereignty on the Isthmus as was given to us by our treaty with Panama. In addition he urges such money reparation by the nation as would make good any financial loss that Colombia has suffered by her nine years' loss of her richest province.

INSTRUCTIONS FOR TRACK MEN ("DON'TS FOR PLATELAYERS")—By A. J. Beaton, M. Inst. C.E., F.S.A., Assistant Engineer-in-Chief, South African Railways. Johannesburg, South Africa. Paper, 3¼x5¼ in., pages 40, 4 cuts in text.

The instructions in this pamphlet, which the author terms simple hints on track maintenance, are on the lines of the instruction books issued to roadmasters and section foremen in this country. They are unusual, and perhaps more significant, in that they tell directly what not to do, leaving the reader's sense of inference to tell him what he should do. The instructions are printed in English and Dutch, the former covering about 20 pages.

REPORT ON THE CONDITION OF THE CLEVELAND WATER SUPPLY, ON THE PROBABLE EFFECT OF THE PROPOSED CHANGES IN SEWAGE DISPOSAL AND ON THE VARIOUS SOURCES OF TYPHOID FEVER IN CLEVELAND, to the Hon. Newton D. Baker, Mayor of Cleveland, Ohio —By Daniel D. Jackson, Sanitary Expert. May 25, 1912. Cloth; 6x9 in.; pp. 148; numerous folding maps and diagrams.

Many valuable tabular and graphical data, both local and drawn from other cities for comparative purposes, make this report one which will probably be desired by every engineer and sanitarian concerned with sewage disposal and the sanitary qualities of public water-supplies, both with particular reference to typhoid fever. The author concludes that the water-supply of Cleveland is so rarely and slightly affected by sewage pollution that there is no present sanitary and economic warrant for water filtration. He advises that the use of hypochlorite be continued, that a duplicate water intake-tunnel be built and that works to lessen the pollution of the Cuyahoga River be built.

REPORT ON THE PROPOSED USE OF A PORTION OF THE HETCH HETCHY, ELEANOR AND CHERRY VALLEYS WITHIN AND NEAR TO THE BOUNDARIES OF THE STANISLAUS U. S. NATIONAL FOREST RESERVE AND THE YOSEMITE NATIONAL PARK as Reservoirs for Impounding Tuolumne River Flood Waters and Appurtenant Works for the Water Supply of San Francisco, Calif., and Neighboring Cities, to James Rolph, Jr., Mayor of San Francisco, and Percy V. Long, City Attorney—By John R. Freeman, Providence, R. I. With a Letter of Transmittal to the Honorable Secretary of the Interior and the Advisory Board of Army Engineers. San Francisco: Board of Supervisors. Cloth; 9x12½ in.; pp. 401 + lxv. $3.

Acting on a "hurry up order" from the Secretary of the Interior, the city of San Francisco engaged John R. Freeman as consulting engineer to present a report in answer to an earlier order to San Francisco to show cause why the federal permit of rights in the Hetch Hetchy Valley desired by the city for water-supply purposes, as granted by Ex-Secretary Garfield, should not be revoked. Mr. Freeman, with a personal staff of Eastern and Western assistants, and with the coöperation of a number of prominent San Francisco engineers, in the short period from about June 1 to Aug. 1, produced the volume before us, which is a notable addition to the series of hydraulic reports for which he has become famous. Text, maps, diagrams, halftone views and tables are used to present a revised and greatly enlarged scheme for a water-supply for San Francisco, Oakland and the bay cities generally, and to show how superior this supply would be as to quality, quantity, economy and ultimate power possibilities to one from any other of the many sources which have been advocated as a substitute for the Hetch Hetchy supply. Following Mr. Freeman's main report are a number of supplementary reports by himself and by other engineers, the latter including Horace Ropes (who was associated with Mr. Freeman), C. E. Grunsky, J. H. Dockweiller and Allen Hazen. The report of Mr. Freeman contains text and halftones designed to show that the Hetch Hetchy reservoir would not, through flooding a mountain meadow greatly admired by nature lovers, result in any great net sacrifice of natural scenery, since a mountain lake and scenic roads would be substituted for a meadow now accessible only with difficulty. Other data are presented to show that a reasonable sanitary protection of the water-supply would not exclude visitors from the Hetch Hetchy Valley and drainage area. A lengthy abstract of the report will be given in a later issue of ENGINEERING NEWS.

## Publications Received

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. The amount of postage necessary can be estimated approximately from the stated size of the book or pamphlet and the number of pages it contains. Reprints of papers read before engineering societies and printed by the authors for private circulation can often be obtained without cost by addressing the author, whose name and address is always given when known. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of a reprint of a society paper to the author of the paper. The stated American prices of foreign books are based on 40 cents per shilling and per mark for British and German books, respectively, and 30 cents per franc for French books, the extra allowances being for importation costs.]

ANALYSIS OF PAINT AND VARNISH PRODUCTS—By Clifford Dyer Holley, M. S., Ph. D., Chief Chemist, Acme White Lead & Color Works. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5½x8¼ in.; pp. viii + 292; illustrated. $2.50, net (10/6, net).

BROOKLYN ENGINEERS' CLUB—Proceedings for 1911. Constitution and By-Laws and Annual Report of the Board of Directors. Brooklyn, N. Y.: The Club (Jos. Strachan, Secretary, 117 Remsen St.) Cloth; 6x9 in.; pp. 185; illustrated. $2, net.

CENSUS OF THE COMMONWEALTH OF AUSTRALIA, APRIL 3, 1911. Bulletin No. 13, Localities. Melbourne: Commonwealth Bureau of Census and Statistics. Published under the authority of the Minister of Home Affairs by G. H. Knibbs, Commonwealth Statistician. Paper; 8x13 in.; pp. 233.

THE CITY PLAN OF NEWARK, N. J.—Report on the Comprehensive Planning of the Metropolitan District of Greater Newark, Submitted to Morris R. Sherrerd, Chief Engineer, Department of Public Works, by Charles Frederick Puff, Jr., City Planning Engineer, Department of Public Works, July 1, 1912. Paper; 7½x10¾ in.; pp. 52; 28 illustrations and folding maps.

THE CURTISS AVIATION BOOK—By Glenn H. Curtiss and Augustus Post. With Chapters by Captain Paul W. Beck, U. S. A., Lieutenant Theodore G. Ellyson, U. S. N., and Hugh Robinson. New York: Frederick A. Stokes Co. Cloth; 5x7¾ in.; pp. x + 307; numerous illustrations. $1.35, net.

THE DESIGN OF STEEL MILL BUILDINGS AND THE CALCULATION OF STRESSES IN FRAMED STRUCTURES—By Milo S. Ketchum, C. E., Dean of College of Engineering and Professor of Civil Engineering, University of Colorado; Consulting Engineer. Third edition, enlarged. New York and London: McGraw-Hill Book Co. Cloth; 6½x9 in.; pp. xvi + 556; 265 text illustrations and 7 folding plates; 65 tables. $4, net, postpaid.

EDUCATION DEPARTMENT BULLETIN New York State Library Bibliography 51—A Selection from the Best Books of 1911 With Notes. J. I. Wyer, Jr., Director of State Library. Albany, N. Y.: University of the State of New York. Paper; 5¾x9 in.; pp. 65.

FOREST TAXATION—By C. R. Pettis, F. E., Superintendent of State Forests. Bulletin No. 8. Albany, N. Y.: Bureau of Publication, New York State Conservation Commission. Division of Lands and Forests; M. H. Hoover, Chief of Publication. Paper; 6x9 in.; pp. 19.

THE FREEZING-POINT, BOILING-POINT AND CONDUCTIVITY METHODS—By Harry C. Jones, Professor of Physical Chemistry in The John Hopkins University. Second edition, completely revised. Easton, Penn.: The Chemical Publishing Co. Cloth; 5¼x8 in.; pp. vii + 75; 15 text figures. $1.

GASOLINE ENGINES: THEIR OPERATION, USE AND CARE—A Comprehensive, Simple and Practical Work, Treating of Gasoline Engines for Stationary, Marine or Vehicle Use. Containing also a complete table of Motor Troubles and Remedies and a full Glossary of Technical Terms Used in Connection with Gasoline Engines. By A. Hyatt Verrill. New York: The Norman W. Henley Publishing Co. Cloth; 5x7½ in.; pp. 275; 152 text illustrations. $1.50.

GEOLOGIC ATLAS OF THE UNITED STATES—Llano-Burnet Folio No. 183. By Sidney Paige. Washington, D. C.: U. S. Geological Survey. Stiff paper; 18½x22 in.; pp. 18; 15 illustrations; 3 maps.

HIP AND VALLEY DESIGN. DETAILS, FORMULAE AND GRAPHICS; ROOFS, HOPPERS AND PIPE LINES—By H. L. McKibben and L. E. Gray, Engineers with American Bridge Co. Edited and published by J. E. Banks [Engineer, Bureau of Standards], American Bridge Co., Ambridge, Penn. Stiff paper; 7x9½ in.; pp. 30. $2, postpaid.

THE JOURNAL OF THE MUNICIPAL SCHOOL OF TECHNOLOGY, MANCHESTER [England]—A Record of Investigations undertaken or published by members of the teaching staff and students of the school during 1911. Vol. V. Published by the Education Committee. Stiff paper; 7x9¾ in.; pp. 276; illustrated.

THE MODERN GASOLINE AUTOMOBILE: ITS CONSTRUCTION, OPERATION, MAINTENANCE AND REPAIR—A Practical, Comprehensive Treatise Defining All Principles Pertaining to Gasoline Automobiles and Their Component Parts. By Victor W. Page, M. E., Late Technical Editor of "The Automobile Journal." New York: The Norman W. Henley Publishing Co. Cloth; 5½x8¾ in.; pp. 693; 380 text illustrations; numerous charts. $2.50.

THE NEW CITY GOVERNMENT—A Discussion of Municipal Administration Based on a Survey of Ten Commission Governed Cities. By Henry Bruere, Director of the New York Bureau of Municipal Research. William Sheperdson, of the Staff of the Bureau of Municipal Research, Cooperating in the Collection and Tabulation of Material Respecting Commission Government. New York and London: D. Appleton & Co. Cloth; 5x8 in.; pp. xiii + 438; 10 folding plates. $1.50, net. $1.62, postpaid.

NOTES ON MINERAL WASTES—By Charles L. Parsons. Bulletin No. 47, U. S. Department of the Interior, Bureau of Mines; Joseph A. Holmes, Director. Washington, D. C.: Pub. Doc. Paper; 6x9 in.; pp. 44.

OFFICIAL PROCEEDINGS OF THE WESTERN RAILWAY CLUB for the Club Year 1911-1912. Chicago: Published by the Western Railway Club. Cloth; 6x9 in.; pp. 278; illustrated.

PROCEEDINGS OF THE FOURTH NATIONAL CONFERENCE ON CITY PLANNING, BOSTON, MASS., MAY 27-29, 1912. [Flavel Shurtleff, Secretary, 19 Congress St., Boston, Mass.] Cloth; 6x9½ in.; pp. x + 232.

REPORT OF THE METROPOLITAN SEWERAGE COMMISSION OF NEW YORK (1912) on the Present Sanitary Condition of New York Harbor and the Degree of Cleanness Which Is Necessary and Sufficient for the Water. New York: The Commission, 17 Battery Place. Cloth; 9x12½ in.; pp. 457; 147 text figures and 5 plates.

REPORT OF THE STATE COMMISSION OF HIGHWAYS OF NEW YORK For the Year Ending Dec. 31, 1911. Albany, N. Y.: Pub. Doc. Cloth; 5½x9 in.; pp. 651; 1 map (in pocket).

ROAD LEGISLATION AND ADMINISTRATION IN IOWA—By John E. Brindley, A. M., Ph. D.; Associate Professor of Economics and Political Science. Bulletin No. 28, Engineering Experiment Station, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa. Paper; 6x8¾ in.; pp. 112.

SCIENTIFIC AMERICAN REFERENCE BOOK—Edition of 1913. Compiled and edited by Albert A. Hopkins (for Part I. Statistical Information), Editor of Scientific American Cyclopedia of Formulas, and A. Russell Bond (for Part II. Scientific Information) Editor of Handyman's Workshop and Laboratory. New York: Munn & Co. Inc. Cloth; 5½x8 in.; pp. 597; 100 text illustrations. $1.50, net.

SIXTH ANNUAL REPORT OF THE METROPOLITAN WATER BOARD—Report on the Results of the Chemical and Bacteriological Examination of the London Waters for the Twelve Months Ended March 31, 1912. By Dr. A. C. Houston, Director of Water Examination, Chemical and Bacteriological Laboratories, 20 Nottingham Place, W., London, England. Paper; 8x13 in.; pp. 61.

THE SPECIFIC HEAT OF WOOD—By Frederick Dunlap, Forest Assistant U. S. Department of Agriculture Forest Service, Bulletin No. 110. Henry S. Graves, Forester. Washington, D. C.: Pub. Doc. Paper; 6x9 in.; pp. 28; illustrated.

STATE OF RHODE ISLAND—Annual Report of the Commissioner of Dams and Reservoirs, made to Gov. Aram J. Pothier, January, 1912. Providence, R. I.: Pub. Doc. Paper; 6x9½ in.; pp. 21; many folding and other plates.

STREET PAVEMENTS AND PAVING MATERIALS—A Manual of City Pavements: The Methods and Materials of Their Construction. By George W. Tillson, C. E., Consulting Engineer to the Borough President of Brooklyn, City of New York. Second edition, revised and enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. xii + 651; 97 text figures. $4, net (17/- net).

SUBSOIL WATER OF CENTRAL UNITED STATES—By W. J. McGee, Soil Water Expert, Bureau of Soils. The Present Outlook for Irrigation Farming. By Carl S. Scofield, Agriculturist in Charge of Western Agricultural Extension, Bureau of Plant Industry. Seasonal Distribution of Labor on the Farm. By W. J. Spillman, Agriculturist in Charge of the Office of Farm Management, Bureau of Plant Industry. [Reprints from Yearbook of the Department of Agriculture for 1911.] Washington, D. C.: Pub. Docs. Paper; 6x9 in.; pp. 12, 12, 16, respectively.

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